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Forthcoming Events.

DECEMBER 12.

Institute of Metals (Swansea Local Section):—Discussion at Swansea on "The Design of Furnaces for Annealing and Heat Treatment."

Institution of Production Engineers:—General meeting in London. "Heavy Machine Tools," Paper by C. D. Andrew.

DECEMBER 13.

Institute of British Foundrymen (Newcastle-on-Tyne Branch):—Ordinary meeting at Newcastle. Paper by J. G. Pearce.

Institute of British Foundrymen (Wales and Monmouth Branch):—Ordinary meeting at Newport. "Testing Castings." Paper by F. C. Edwards.

Swansea Technical College Metallurgical Society:—General meeting at Swansea. "Estimation of Tin in White Metals and Steel," Paper by Capt. J. R. Green, B.Sc., A.I.C.

DECEMBER 16.

Sheffield Metallurgical Association:—Ordinary meeting at Sheffield. "Body in Steel," Paper by J. Kent Smith.

DECEMBER 19.

Institute of British Foundrymen (London Branch):—Annual dinner in London.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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The Sphere of Die Castings.

Although die casters employ neither moulder nor pattern maker, they are still foundrymen, and there is no reason, other than the lack of experience, why the ordinary foundryman should not run such a business in connection with his own trade. If he feels that the number of orders he is likely to receive would not warrant the running of such a department, then he should ally himself with a works specialising in this direction. Such an arrangement will prevent work being in the wrong place. The die caster, if he feels himself in competition with the non-ferrous foundryman, will be inclined to tackle work outside his true sphere, whilst the latter is prone to take on work which could be more economically tackled by the former.

It is generally assumed that the jobs which are especially suitable for die castings are those of which only very large quantities are required, owing to the cost of the dies. This is only a partial statement of the truth. The ideal job for the die caster is one of which reasonable quantities are required: which involves much subsequent machining and which, when cast in sand, would require an initial machining to provide a "spotting face" so that it could be "jigged." Die castings are now so well made that they will invariably fit into a jig, and no machining is ever necessary to provide a spotting face.

Not all non-ferrous alloys are suitable for die castings, but there is a wide range of material now available, outstanding amongst which are 60 : 40 brass, the L. 8 aluminium alloy and aluminium bronze. The last alloy is very much easier to die-cast than to sand-cast. A certain amount of aluminium-silicon alloy, too, is being die-cast advantageously.

In the production of a sand casting there are so many variable that more than the whole of this column could be taken up by their mere recitation, but for die casting there are but three factors to control after the production of a suitable mould or die. They are the chemical composition of the alloy, casting temperature, and mould dressing.

The production of the mould is a problem which requires the closest co-operation of the moulder and a skilled tool-room mechanic. For sheer mechanical cleverness some are unsurpassed in any branch of small-scale engineering. The control of the composition of the alloy requires but the application of easily available existing information, whilst the control of casting temperature is even more simple. The mould dressing or "dope" is extremely important, and may represent the difference between success and failure. On this matter, however, nothing but emperical data is available. It has been stated that in the same works two shops use entirely different "dopes" with equal success, but apparently the human element definitely precludes their interchangeability.

Brass foundrymen can rest assured that the die casters do not want plain, straightforward, small jobs on which there is little or no machining, as they can be mounted on a plate and turned out more rapidly and economically by machine-moulding. The true sphere of the die caster is the elimination or, at least, large reduction of machining operations. As normally, engineers pass such orders to foundrymen, the latter should early make up their minds whether they will pass on the orders to the die caster or set up a department of their own, because to continue manufacturing by methods which have become economically obsolete is, nationally regarded, bad business.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Comparative Melting Tests in a Standard Cupola and a Schurmann Furnace of the same Over-all Dimensions.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I think that the above article by Messrs. Piwowarski and Broglio in THE FOUNDRY TRADE JOURNAL of October 9, calls for some reply, particularly as it is to be noticed that in German foundry journals this technical contribution by University Professors has been very vigorously attacked by such well-known foundry specialists as Mr. Braun (Die Giesserei, No. 45) and Engineer C. Rein, Hanover (Giesserei-Zeitung, No. 20), who both call attention to the fact that the authors describe the furnace used for the tests as an ordinary standard cupola in an endeavour to work out results favourable to the Schürmann furnace. I scarcely think that in England, where the standard coke consumption is usually 10 per cent. and less, a cupola can be described as "standard" which requires a 13 per cent. charge of coke.

In comparing melts, the authors take the Schürmann furnace as melting 12.9 tons and the ordinary furnace as melting 17.5 tons, but it should be noted that the latter is not even furnished with the same kinds of pig-iron or scrap, but with varieties which are considerably more difficult to melt. Naturally, the result is that not only different products are obtained, but considerably more fuel is required for the ordinary cupola. In spite of this, the Schürmann furnace melts in 158 minutes 4.5 tons less than the ordinary furnace melts in 161 minutes, practically the same time.

Although the Schürmann furnace melts an appreciably smaller quantity, it requires in comparison with the ordinary furnace a blast pressure 18 per cent. greater. This is not a characteristic of the Schürmann furnace itself, but is attributed to the fact that the blast pipes are about 6 ft. longer. It seems to me that the real reason for this is given in the German Foundry Engineer Rein's article, "Die Windvorwärmung für den Kupolofenbetrieb" (preparatory heating of blast for cupola work) which appeared in the "Giesserei-Zeitung, No. 15," of July 1, 1923.

According to known scientific rules, air that has been heated increases in volume, but without increase of the oxygen. Thus either the fan must draw up a greater volume of previously heated air or oppose the increased pressure due to the previous heating of the air. In both cases an additional pressure is required. Besides this, it must be taken into consideration that with furnaces which have the air led in in such a way that the coke burns as quickly as possible, a hotter iron is produced with lower coke consumption. Tuyeres which are not too big and are directed downwards, tend to concentrate the melting zone and produce a uniformly heated melting of the various qualities of iron furnished. Foundry experiments made both in England and America in this connection bear out this statement. If now the Schürmann furnace, in spite of the disadvantages stated above, produces iron which is about 50 deg. C. higher in temperature (the writers of the article in question do not give the actual temperatures of the melted iron during the trials) previous heating of the air cannot be the reason as alleged. Firstly, for the beginning of the melt, the Schürmann furnace has not warmed receivers, and secondly, it cannot be supposed that the blast temperatures stated could be obtained at all with such a small warming apparatus.

Besides this, in No. 43 of the journal, "Die Giesserei," Engineer Bernhard Osann, in discussing the quantities of cupola lining melted away, gives the quantity of coke used by the Schürmann furnace as 15.52 per cent., the slag as 25 lbs. per 210 lbs. of iron furnished, and loss of iron with slag as 14.15 per cent. FeO. This does not correspond with the claims for the Schürmann furnace made by Messrs. Piwowarski and Broglio.—I am, sir, yours, etc.,

G. C. CASTLE.

Liverpool.

Patent Specifications.

Particulars of complete specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of Lonsdale Chambers, 27, Chancery Lane, London, W.C.2. Printed copies of the specifications in the following list are now on sale.

223,617 and 223,622. BORCHES, W., and STIMSON, R. W. Purifications of alloys containing iron and chromium, molybdenum, or uranium. April 24, 1923.

207,204. FARBWERKE VORM MEISTER, LUCIUS & BRUNING. Process for providing a metal coating on a core. November 18, 1922.

216,484. GENERAL MOTOR RESEARCH CORPORATION. Alloy articles. May 22, 1924.

201,555. CHEMICAL TREATMENT COMPANY. Process of desulphurising iron, steel, ferro-alloys and other metals and composition of matter for use therein. July 29, 1922.

223,969. SCHMIDT, K. Method of separating the particles of metal from a mixture of metallic oxide and such particles of metal. July 26, 1923.

223,995. BENGOUGH, G. D., and STUART, J. M. Process of producing a coloured surface on aluminium alloys. August 2, 1923.

224,000 HYDE WELDING COMPANY, LIMITED, WALTON & BROWN, LIMITED, and BARLOW, J. R. Manufacture of metallic tubes having welding joints. August 3, 1923.

206,144. HEIMSOTH & VOLLMER GES. Reverberatory furnaces. October 27, 1922.

206,162. METALLISATION, LIMITED. Process for welding aluminium. October 27, 1923. Convention date not granted.

224,113. HASSALL, J. K., and HARRIS, A. Nozzle for ladles used in pouring molten metal. December 27, 1923.

An Interesting Foundry Competition.

Details of an interesting competition appear in our advertisement columns. It has been organised by Messrs. Thomas E. Gray & Company, Limited, of 119, High Holborn, London, W.C.1, who are well known to the foundry trades as manufacturers of Silacene—a plastic refractory, which has many uses in foundry practice. The scheme is to invite *bona fide* foundrymen to prepare the layout of an advertisement with the largest possible number of words beginning with the letter P, together with the word "Silacene." It is not solely quantity of words which is to count, but their clever arrangement, though the former is of prime importance. The actual details of the competition will appear amongst the advertisement pages in our next issue. We understand that four prizes are to be awarded of a total value of £15. The advertisement manager of THE FOUNDRY TRADE JOURNAL has consented to judge the competition.

London I.B.F. Branch Dinner.

The annual dinner of the London Branch is to be held on December 19, at 7 p.m., at the Engineers' Club, Coventry Street. As a number of people connected with the foundry industry are to be in London on that day, they are cordially invited to participate. Tickets, price 10s. 6d. each, are to be obtained from Mr. H. Shillitoe, Messrs. British and Continental Traders, Limited, 50, High Holborn, London, W.C.1, who is acting as honorary secretary *pro tem.*

Foundry Query.

Cost of Lining Cupolas.

I should be pleased if one of your readers could give me the average cost of lining completely a 60-in. cupola with firebricks in the ordinary way. —"SILICATE," Blackburn.

MR. W. G. HOLLINWORTH'S condition is reported to be more satisfactory at the time of going to press.

SIR JOHN DEWRANCE, K.B.E., the recently-elected President of the British Cast-Iron Research Association, has been appointed High Sheriff-elect for the county of Kent.

The Melting and Casting of High-duty Irons.*

By F. Hudson.

By high-duty irons is meant that material used for the manufacture of castings which have to withstand both pressure and friction, as in loco-cylinders.

The suitability of such castings in service is mainly dependent upon their mechanical tests, which are controlled as far as possible by chemical analysis and the rate of cooling of the casting. When it has been decided what tests are required, an analysis is fixed, termed the final or finished analysis, and it is desirable to work to this to

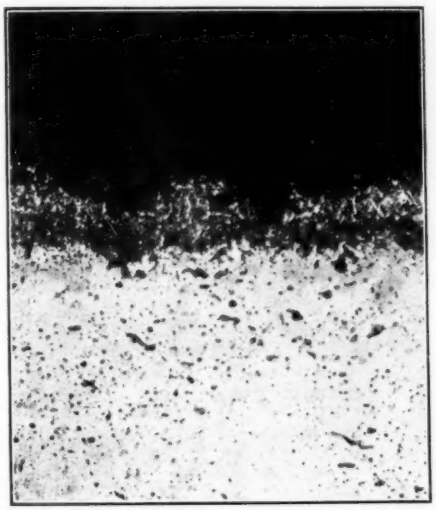


FIG. 1.—WROUGHT-IRON BAR JUST BEFORE MELTING, SHOWING CARBON ABSORPTION. × 50 DIAS.

very near limits. This is very difficult, due to the exercising of a certain amount of unavoidable guesswork brought about by the passing of definitely analysed material through a furnace, the changes in which are not known. If these changes were known, it would be possible to have more control, if more control were possible, over melting operations, and to work to definite analysis, as is the case in the reverbatory or electric furnace. It was with these views in mind that an attempt has been made which, although not nearly conclusive, may clear up obscure points.

The Melting in the Cupola.

The melting of cast iron has been very badly neglected in the past, and very little real progress has been made. The cupola furnace is in universal use in foundries at the present time, due to its cheap cost of working and rapidity of melting large quantities of metal. As a furnace which has to be controlled to give definite results, nothing could be very much worse. New developments which have from time to time been brought out tend to perfect the working of the cupola or to cheapen the running cost. They do not necessarily improve the metal, and they decidedly give no further scientific control over the actual melting operations. In this respect mention may be made of the latest innovation in cupola design, namely, the Schurmann hot-blast cupola. In this furnace, of German design, the saving of coke by the utilisation of a hot side-blast amounts to 22 per cent., including the bed coke, or 51½ per cent. saving of charged coke over the ordinary standard cupola. However, there seems to be a heavy oxidation of the elements in iron made in this new furnace. Again, the use of receivers and mechanical charging has only come into use in latter years.

Another matter worthy of attention is the syphon tapping block, suggested by Mons. Ronceray, for obtaining pure metal free from slag. The cupola used by his firm is of the drop-bottom type, suspended from the charging stage without legs, which facilitates the clearing up of all rubbish after the day's blow. The working of this special tapping block is as follows:—The metal flows into the centre of the ganister block and out of the first hole. This hole is then closed or "bottled up." More metal is melted, and it reaches the level of the second hole, which is also closed. Still further melting takes place, and it begins to flow down the spout from the top hole. No tapping and closing of this hole is done during the cast, the flow of metal being wholly controlled by the starting or stopping of the air pressure in the cupola.

Many other improvements may be cited, but not one has any influence on the actual control of the melting of cast-iron mixtures as regards working to a definite analysis specification.

Many theories have from time to time been put forward suggesting the changes taking place inside the cupola furnace, but they have usually been discarded through unreliable data. For instance, at the present time many foundrymen believe that a temperature to melt steel cannot be obtained in the cupola. Another investigator put forward the suggestion that the fluidity of molten cast iron was dependent upon the amount of combined carbon in the pig-iron, but omitted to give conclusive evidence that this was so.

Before considering the changes taking place during melting, it is essential that the cupola be worked to the best advantage. This can only be obtained by calculation and experimental running over a period. It must be borne in mind that successful cupola working is very rarely the most economical, as far as coke consumption is concerned. In this respect rapid and hot melting is essential. The appearance of the flame at the charging-door when melting is an excellent index if the furnace is running well. There should not be, as is so often seen, a continuous, persistent "flaming up" through each topmost charge. Cupolas are too often left to be managed by practically unlettered men, who, through lack of scientific knowledge, dare not deviate from their present practice. The essentials to be sought in good

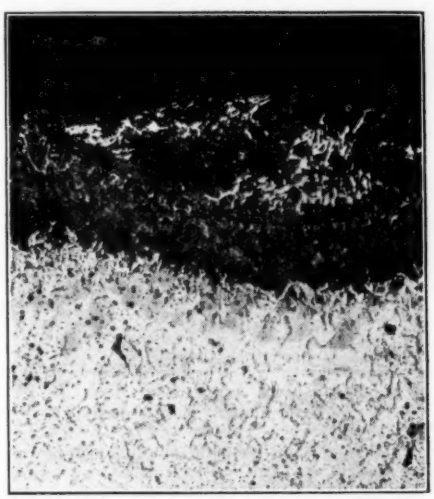


FIG. 2.—WROUGHT-IRON BAR IN MELTING ZONE. × 50 DIAS.

cupola practice may be stated to be: (1) Careful weighing of all pig-iron, coke, etc., including air: (2) careful analysis in conjunction with physical tests of all raw materials used; (3) correct fluxing; (4) rapid and hot melting; (5) the brickwork at the charging-door should never exceed black or dull-red heat until the last 30 minutes of the blow; and (6) correct flame at the charging-door. (A bluish-pink flame, clinging to every little projection and ledge in the chimney stack, and now and again running down and burning at an opening

* Abstract of a Paper read before the Junior Section of the Newcastle Branch of the Institute of British Foundrymen, Mr. E. J. Rang presiding.

in the charges. If this flame is obtained, it is not necessary to look at the metal, as it denotes good practice.)

A large amount of very useful data on how to obtain the best results in cupola practice is to be found in numerous text-books and in the FOUNDRY TRADE JOURNAL.

Cupola Reactions.

In the first instance, there is still a doubt in foundry practice as to what is the maximum temperature that can be obtained in the foundry cupola. This will obviously vary in different foundries, according to whether their practice is good or bad. In good practice at least 1,650 deg. C. can be obtained in the chief combustion zone. In recent technical literature German metallurgists measured the temperature in this zone, which gave 1,650 to 1,700 deg. C. A certain amount of air is supplied through the tuyeres at some particular rate in order to get the maximum rate of combustion according to the exposed surface area of the coke. The size of the coke pieces and the physical structure of the coke surface considerably affect this rate of combustion. The air encounters a mass of coke, through which it can only penetrate by tortuous routes leading in all directions, and tending to travel upwards more rapidly than inwards, due to the resistance of the opposing tuyeres' air current and the lack of outlet other than at the top. The zone of highest temperature, however, will tend to come nearer the lining continuously the higher any one plane is carried, as a certain distance must be travelled by the air before maximum combustion takes place. Taking a plane at any point a little above the tuyeres, melting probably takes place across the whole area. The atmosphere of this zone should be neutral, or only slightly oxidising.

Constant blast pressure and volume is most important in cupola working, as this is the absolute index of a constant melting zone. In this respect another point, which is often lost sight of, is that the melting zone is fixed by the tendency of the air to travel upwards. Any disturbing factor, such as a large open slag-hole, will lower the melting zone, and possibly give dull metal. The

FIG. 3.—CARBON ABSORPTION FROM MOLTEN CAST IRON. × 50 DIAS.

slag-hole in cupola working should only be opened when necessary, and then closed as soon as possible.

Ordinary mild steel, with a melting point of nearly 1,500 deg. C., will melt quite easily in this zone at its actual melting temperature, no carbon absorption taking place before melting to lower its melting point. Some time ago an eight-ton cupola in the author's charge melted ten tons of ordinary mild steel, with ferro-alloys to give an iron of the following composition cast in sand-pigs :—Total carbon, 2.94; silicon, 1.26; manganese, 0.76; phosphorus, 0.09; and sulphur, 0.115 per cent., and giving 15.5 tons tensile.

Obviously the maximum temperature in the combustion zone is well above 1,500 deg. C. One may confidently state that the melting zone in the ordinary foundry cupola is at least 1,650 deg. C. in good practice. The next point for consideration is the amount of carbon absorbed by the charges before melting in their descent down the cupola. The following experiments were done during ordinary practice in the eight-ton furnace referred to previously :—

Carbonising of Metal During Descent in Cupola.

A ⅝-in. wrought-iron bar of sufficient length to extend from the charging-door to the melting zone was placed in the furnace on top of a charge of cast iron and allowed to descend the cupola, with

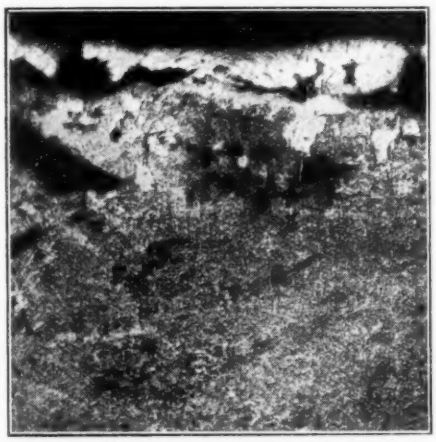


FIG. 4.—SHOWING DECARBONISATION DUE TO OXIDISING ATMOSPHERE. × 50 DIAS.

that charge, into the melting zone. After a certain time the bar was withdrawn by means of a crane, through the following charges, and the end examined.

Wrought iron was chosen because of its strong affinity for carbon. If any carbon is absorbed by the iron or steel when melted in the cupola, an iron or steel very low in carbon will tend to absorb more than high-carbon material, such as is usually melted for cast-iron mixtures. The main point noted immediately upon extraction of the bar was the pronounced difference of temperature zones, which seemed to consist of three different temperatures :—(1) The very hot zone; (2) radiation zone of slightly lower temperature, immediately above first zone; and (3) low-temperature zone, representative of the usual stack heat.

It was noted that the drop in temperature from zone two to three was from bright red to nearly black heat within a few inches. When examined under the microscope very little carbon penetration was found. Fig. 1 shows the carbon penetration before melting, whilst Fig. 2 shows the melted portion of the bar. It should be especially noted that no oxidation can be traced on the outside, and that it is quite possible that the melting of other lower melting-point material may possibly induce easier melting of the iron or steel. A trace of this easier-melting material will be noted adhering to the bar. Even to-day many hold the opinion that when hard spots are encountered in machining iron castings those hard spots should be ascribed to steel. How this opinion originated is hard to say, but it must be perfectly obvious that when steel is melted in the cupola, even as very small punchings, the temperature of melting and the very high solvency of cast iron for steel, together with the subsequent disturbances due to tapping into the ladle, yield relatively homogeneous metal. Fig. 3 illustrates the powerful solvency of cast iron for mild steel. A ⅝-in. mild-steel bar was moved up and down in a ladle of molten cast iron, and in about two minutes was reduced to ¼ in. The microphotograph, taken at a magnification of 50 dias., shows that the outside of the bar has absorbed carbon from the molten iron, and so lowered its melting point, this taking place in each successive layer of steel exposed by the action of the cast iron. Analysis of other steel sections passed through the cupola and trapped at the melting zone have shown that this increase, to all intents and purposes, does not affect the analysis

for carbon, and cannot be detected by ordinary routine works analysis and sampling. For instance, steel charged into the cupola with carbons of 0.28 per cent. and 0.33 per cent. respectively gave 0.23 and 0.37 per cent. on being trapped just before melting. If any excess blast be used, as, for instance, when the furnace is "blowing down," instead of this layer of carbon we get a decarbonised layer of iron, as shown in Fig. 4. No carbon absorption seems to take place in the ordinary run of cast-iron scrap and pig-iron usually melted.

However, it is interesting to note the ill-effects of excessive blast, causing the oxidising atmosphere so detrimental to good melting for high-duty castings on a high-carbon hematite iron. This specimen was retained by the lining after the bottom had been dropped, and exhibited a most interesting point. The pig had half-melted with the formation of a high melting-point skin. This skin seems as if it had enclosed a core of molten iron, and then collapsed, due to either weight or temperature. Upon analysis the skin showed very heavy decarbonisation. Fig. 5 shows this pig. The analysis of the skin was found to consist of 6.76 per cent. sand and 93.24 per cent. magnetic material, this magnetic material being further analysed as follows:—Total carbon, 2.0; silicon, 1.30; manganese 0.94; phosphorus, 0.06; and sulphur, 0.100 per cent; in comparison with the centre of the pig, which analysed:—Total carbon, 4.19; silicon, 1.46; manganese, 1.20; phosphorus, 0.054; and sulphur, 0.04 per cent. The extent of oxidation will be noticed.

FIG. 5.—DECARBONISED OR OXIDISED SKIN ON HEMATITE PIG.

At first it was thought that this skin had been formed by the refractory sand usually adhering to the pig, but similar results have been obtained with perfectly clean-machined samples. In some of these cases it seemed that the iron had first started to melt from the centre. A refractory skin on pig irons would be a decided advantage in cupola melting so long as this skin was not formed by some such element as might prove injurious to correct melting. The reason for this suggestion will be further considered in a later part of this Paper. These experiments give some idea of the changes taking place before melting, and will end in a position according to their respective melting points in or just above the melting zone. For instance, steel will melt lower down the furnace than low-phosphorus iron, likewise high-phosphorus material will melt above low-phosphorus metal. The melting points are as follows:—Steel 0.2 per cent., 1,480; low-phosphoric iron, 1,110; ordinary cast iron, 1,088; and high-phosphoric iron, 1,086 deg. C.

Superheating Cast Iron.

At a first consideration it would seem that for a means of imparting superheat it is not very satisfactory, for the very reason that the molten iron is only in contact with the maximum combustion zone for a very short time. It should be borne in mind, however, that when a piece of cast iron melts it does so just above the hottest zone and falls through the intense combustion zone in the form of small drops. The temperature of the hottest part of the cupola is sufficient in good practice amply to superheat the small weight in a short time.

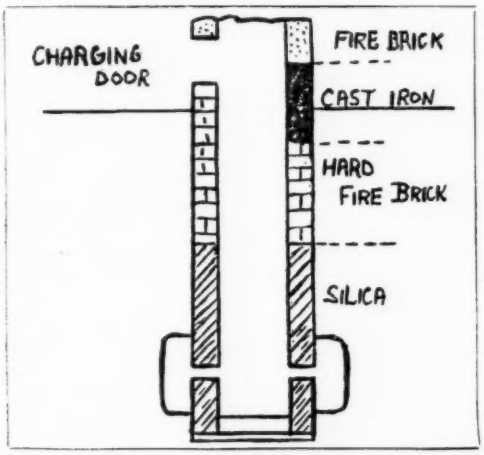


FIG. 6.—SHOWING PROPOSED METHOD OF LINING CUPOLAS.

The following facts are worth noting:—(1) All cast iron is superheated in the true sense of the term superheat; (2) iron and steel is not superheated in the true sense of the word, but by melting at a high temperature and solidifying at a much lower temperature obtain a superheat greater than in the first instance. The changes taking place during and after melting are much harder to determine. The only work that the author has done in this instance is the sampling of the molten iron at the tuyeres and comparing similar iron tapped out of the furnace after contact with the bed coke. It must be borne in mind that these results were obtained after melting in a neutral atmosphere, and could only be applied to another furnace with exactly similar conditions of melting. The main element for control is the total carbon, and these analyses were taken with that in mind. The results are as given in Table I.

TABLE I.—*Analyses of metal above and below the coke bed.*

Above Bed Coke.					Below Bed Coke.				
T.C.	Si.	Mn.	P.	S.	T.C.	Si.	Mn.	P.	S.
4.26	1.68	0.86	0.15	0.045	3.24	1.24	0.71	0.24	0.100
3.65	2.04	0.81	0.70	0.067	3.46	2.06	0.76	0.63	0.076
3.73	2.48	1.20	0.76	0.052	3.57	2.02	0.70	0.61	0.067
3.87	—	—	—	—	3.50	—	—	—	—
3.27	—	—	—	—	3.27	2.54	0.88	0.88	0.055
3.61	—	—	—	—	3.53	—	—	—	—

Conditions for Carburisation.

Due to lack of sufficient time, further analyses have not been obtained, and, although no very definite conclusions may be drawn from them, it seems highly probable that the molten iron absorbs the most carbon when actually melting, and not, as usually supposed, from the bed coke. The four main points for carbon absorption in cupola operations are temperature in the melting-zone, time in the melting-zone, the atmosphere of combustion, and the initial analysis of the material melted. The higher the temperature the more

carbon will be absorbed by the iron in a certain time, according to the facility of applying free carbon. In the cupola the iron itself will receive a temperature of at least 1,500 deg. C. during melting, and at this temperature a large amount of carbon will be absorbed in a very short time. Any further increase of temperature or time in the melting-zone will allow the iron to absorb more carbon. The loss of carbon in molten cast iron in contact with the bed coke is possibly due to the lower temperature in the well. Cast iron, including material with a range of total carbon from

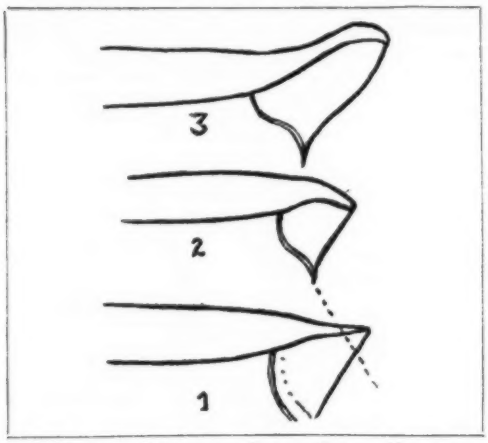


FIG. 7.—FORMS OF LADLE LIPS. NO. 1 IS A BAD FORM, WHILST NOS. 2 AND 3 ARE GOOD.

2.8 to 3.5 per cent., when melted in the cupola, will tend to absorb the maximum amount of carbon that can go into solution at that temperature attained in the melting-zone. At any lower temperature no carbon will be absorbed; in fact, the molten iron will tend to "throw off" carbon in the well of the furnace. At any rate, if the maximum amount of carbon is not absorbed in the melting-zone, it is very probable that enough is absorbed which will not permit of any further addition by the bed coke. High steel mixtures may possibly prove an exception to this rule, due to the larger amount of carbon it will have to absorb. This will conveniently explain why slow-melted hot iron is much higher in carbon than quick-melted hot iron, and also shows that the oxidising atmosphere in a melting-zone gives low total carbons, even when the iron has been in contact with the bed coke.

These little experiments throw light on the changes taking place inside the cupola. For convenience sake, they may be divided up into three zones :—

Zone 1. *Extending from the charging-door sill down to beginning of melting-zone.*—For practical purposes cast-iron and steel mixtures in this zone absorb no extra carbon until actual melting begins.

Zone 2, *or the Actual Melting Zone.*—Cast iron and steel melt just above the hottest zone at their respective melting temperatures, and fall through the hottest zone in small drops. This hottest zone has a temperature of at least 1,650 deg. C., amply sufficient to superheat these small drops. These drops absorb carbon very rapidly, due to their high temperature and with being in intimate contact with incandescent coke, more carbon is absorbed in this zone than in any other part of the furnace. The atmosphere should be neutral.

Zone 3. *Extending from the Melting Zone to the Well.*—The molten metal lying in the well gradually falls in temperature, and in the case of cast iron probably loses carbon. Sulphur is absorbed in this zone, and also to a small degree in the second. It is essential, in order to obtain the best results in cupola melting, to have the correct amount of air to combine with the coke to give a neutral or very slightly oxidising atmosphere. To give low total carbons a certain percentage of steel can be used. The lower the blast pressure, consistent with correct volume, the hotter the metal is, due to a lower melting zone. For high total carbons melt hot but slowly. High melting-point irons with low total carbons, including steel, will give hotter metal than iron with lower melting point. Heavy sections melted with too little coke will give cold metal, due to the molten drops having less distance to fall through the hottest zone. Many other difficulties can be overcome if one appreciates the changes taking place inside the cupola.

Results Summarised.

From a practical standpoint these results may be summarised as follows:—(1) No carbon is absorbed until melting begins. (2) The temperature of the hottest zone in the cupola furnace will melt steel very easily indeed. It has been found to be *at least* 1,650 deg. C. (3) A neutral atmosphere is required for melting high duty work in order to obtain, as far as possible, a set of constant melting conditions. (4) Total carbon can roughly be controlled by dilution with steel and speed of melting. (5) The cupola furnace will superheat cast iron in the true sense of the word, the resulting temperature being slightly affected by the melting points of the material. The higher the melting point the hotter the iron. (6) The most carbon tends to be absorbed by the molten metal in the hottest zone of the furnace. (7) As long as the molten metal is in contact with the fuel, it is not likely that any direct control could be exercised with a definite analysis specification in view. However, some control can be obtained in the melting of cast iron for high duty work if the changes taking place during melting are definitely understood, and steps taken to obtain definite melting conditions.

Melting of Heavy Duty Irons.

These points will be of the same importance, whether steel is included in the mixture or not. The first point is that the analysis of each grade of iron charged should be known, and a mixture calculated by analysis for each important casting, allowing a certain percentage loss due to oxidation found by experience. As far as possible similar sized pieces should be charged, not too heavy, and preferably clean and free from excessive dirt or sand. The bed coke should be measured by volume, and the charged coke by weight. Only the necessary air should be used to give complete combustion of the charged coke in a certain time with the formation of a neutral atmosphere. Every care should be taken to keep a constant standard melting zone, which is influenced by the pressure and volume of blast used, the resistance to penetration of the blast and any openings below the stack outlet such as the slag hole. Proper fluxing, using a slightly

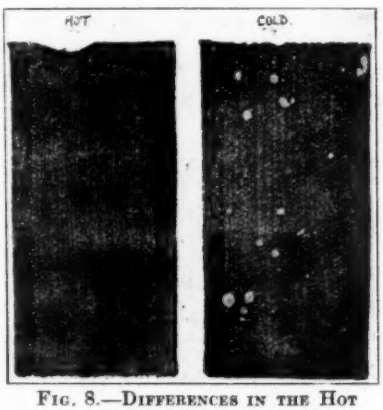


FIG. 8.—DIFFERENCES IN THE HOT AND COLD CASTING OF HIGH-DUTY IRONS.

basic slag, together with hot melting, will keep the sulphur low. This can be obtained by the use of a small amount of manganese ore with the limestone. Careful attention to the small points. Hot melting is essential for good work. Placing charges for important work half-way through the blow gives an advantage in the use of hot ladles and hotter metal.

Refractories.

The temperature required for the hot melting of high duty irons necessitates the best grade of silica bricks. Ordinary fire-bricks are used in

most foundries, but they are far from satisfactory. The most economical way to run the foundry cupola is to arrange the day's output so that a certain sized cupola may be run at full load. This naturally has a very destructive effect upon the lining, and unless suitable bricks are used trouble may be experienced towards the end of the "blow" through the furnace showing red or even "coming through." Firebricks are unable to stand this overloading, for the very reason that they are not made to withstand temperatures usually obtained in the cupola. All furnaces should be lined in some manner similar to that shown in Fig. 6. From the bottom of the well to above the melting zone silica bricks should be used, and from there to the charging door use some very hard brick such as a high iron-content firebrick or magnesite, with hollow cast-iron bricks opposite the charging door. If magnesite bricks are used it is advisable to insulate them from the silica bricks with some neutral material such as high alumina or chrome bricks. The best Sheffield ganister with a high silica content should be used for setting and repairing the silicas. A refractory wash is a very great advantage in closing the pores of the bricks, especially in and below the melting zone. The method used by the author is to incorporate silica bricks in the melting zone and high iron-content firebricks and hollow cast-iron bricks above, and a final wash of high silica ganister in the melting zone. Ordinary quality firebricks can be used above the charging door. This method lasts roughly half as long again as the best grade of firebricks.

Pig-Iron.

Cast iron for high duty irons may be divided into two classes. In the first class is used a

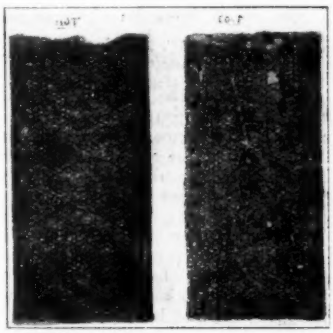


FIG. 9. FIG. 9A.

Fig. 9, contains Gr 2·86; Cc 0·56; Si 1·41; Mn. 0·84; P 0·27 and S 0.103 per cent. whilst Fig. 9A contains Gr 2·85; Cc 0·49; Si 1·37; Mn. 0·78; P 0·28 and S 0·072 per cent

mixture without or with very little steel additions, and in the second class those with a fairly large steel addition, which is commonly called semi-steel. A much better name to differentiate between different steel additions is steel mix iron, as suggested in THE FOUNDRY TRADE JOURNAL, placing the percentage of steel in the mixture before the term. For instance, supposing there is 20 per cent. steel in a certain mixture, that mixture could very conveniently be called 20 per cent. steel mix iron. A very large amount of trouble has been experienced in the past, due to the lack of knowledge in applying this very useful iron. The usual moulding methods in cast iron are not suitable for the use of heavy steel additions, except those simple and regular sectioned castings with large heads, such as cylinder liners or hydraulic rams. The ordinary run of work, such as cylinders, etc., require no more than 10 per cent. steel additions at the most. Every metallurgist or chemist should so control his mixture with a view to obtaining sound castings. This necessitates very close co-operation with the moulding methods employed, and no attempt should ever be made to cast any mould with any high shrinkage iron without insisting upon careful placing of risers and feeding heads.

The ideal cast iron for cylinder and intricate high duty work is an iron with low liquid shrinkage, yet reasonably soft. Grey cast iron does not solidify at once, but does so over a considerable temperature range. The softer this iron usually is the larger this range of temperature from incipient to final solidification. White iron, on the other hand, solidifies without this temperature range. All liquid shrinkage, draws, etc., take place in castings during this period of

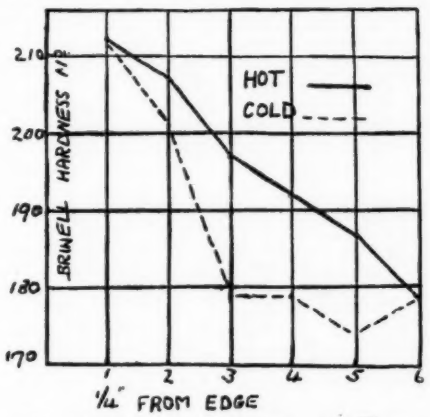


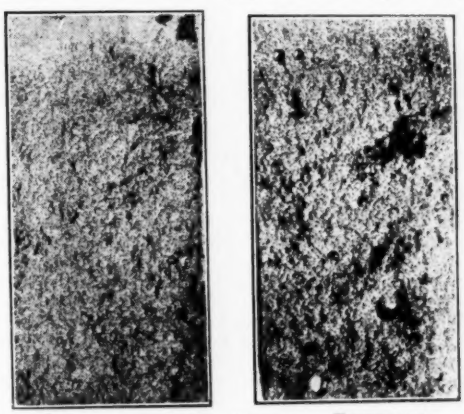
FIG. 10.—SHOWING UNIFORMITY OF HARDNESS THROUGH 2-IN. THICK SECTION.

setting, and it is a very great help if advantage be taken of this fact to obtain, as far as possible, a cylinder iron with a low liquid shrinkage.

Every foundry has its own idea as to which pig-irons are most suitable for the type of castings made. Personally, the writer prefers a synthetic cold blast iron, containing at least 10 per cent. steel, made in a cupola or open-hearth furnace. This is re-melted with silicious hematite (5 per cent. Si) and a slight percentage of steel and domestic scrap for cylinder work. For heavy hydraulic work or large cylinder liners more steel is used, but never over 15 per cent. is employed directly without re-melting. Low total-carbon iron is not recommended for ordinary work, but is quite satisfactory for uniform sections with suitable feeding heads. Perhaps 3.5 per cent. is the best all-round carbon percentage for intricate and cylinder work. When hematite is used for mixing it is advisable to use the 5 per cent. silicon variety, as less is required to make up the silicon to any desired percentage. This saves money and gives a better mixture. All pig-irons should be very accurately and carefully sampled and analysed, as this is essential for correct mixing.

Special Pig-Irons.

Pig-irons bearing alloys such as nickel and chromium, naturally formed from their own ores, will possibly soon come into use, and perhaps revolutionise cast iron. At present there is one on the market, called "Mayari" pig-iron. This is a natural nickel-chrome pig-iron with slight traces



FIGS. 11 AND 12.—SHOWING DEPTH OF CHILL.

of titanium and vanadium, found in Cuba. Another similar ore is found in the Island of Skyros, off Greece. Similar pig-irons are being initiated by the synthetic melting of nickel chrome steel scrap obtained from the breaking up of war vessels.

Coke.

Good coke is one of the most important factors for correct cupola melting. To obtain fast and hot melting together, a brand of coke with certain physical properties is essential. It is usual to buy coke to a certain specified analysis and with certain physical properties. For instance, the following is a specification for coke used in cupola work:—1.0 sulphur; 9.0 ash; 4.0 water; and 6.0 per cent. dust on delivery; all being maximum allowances. The physical properties looked for in good coke are:—(1) Well-developed cellular surface structure; (2) not too dense; (3) rapidity

FIG. 13.—MICRO-PHOTOGRAPH AT 50 DIAS. OF MATERIAL CAST HOT.

of combustion; (4) uniformity of size; (5) hardness to resist abrasion; and (6) freedom from blackheads.

Of these, one of the most important is rapidity of combustion. Experts are divided into two groups on this point. One school of thought says that the combustibility of coke depends upon its density, whether porous or close. Another ascribes it to volatile hydro-carbons. The author is of the opinion that neither of these ideas is correct, but that rapid combustion is due to a certain cellular surface structure on certain cokes which exposes a maximum amount of carbon to the oxygen in the blast. However, this is only an assumption, and still remains to be proved. Many foundrymen are still very dogmatic about the strength of coke. Resistance to abrasion is really the main requisite, and not strength. The pressure on coke, even in large blast furnaces, is not more than 42 lbs. per sq. in. An important saving in cupola working can be made by sorting the unburnt bed coke out of the refuse at the end of the blow. This coke is suitable for drying or pre-heating ladles. In practice, blast-furnace and cupola coke are differentiated, but there is very little difference between them in reality.

Methods in Casting.

It is usual, in grey iron foundries, for the melting staff to have all maintenance of ladles, etc., but the actual pouring gang comes under the moulding department. The writer considers that it is necessary that the works metallurgist or melting department should have control of the pouring operations, as well as ladle maintenance. This is usual in steel practice and many malleable plants. One of the most important factors for the correct pouring of moulds, especially for high duty work, is correctly designed ladles with suitably shaped spouts or lips. These spouts should be deep and well above the level of the metal in the ladle. A comparison of good and bad ladle lips is shown in Fig. 7. It will be noticed that if any cast iron solidifies on the end of the lip in the badly designed ladle (No. 1) the metal, when poured, will not flow down the spout in a controlled stream, but will "slop" over the sides and possibly miss the runner basins altogether. The best design which the author has ever seen used in any foundry is No. 2, commonly used in blast-furnace work, but No. 3 is a very good design, and many ladles in use may be conveniently altered to give this shape by the use of the pneumatic chisel. Another type of ladle employed in the foundry with which the writer is connected is the bottom-poured ladle, as used in steel practice. In the author's opinion, this is the best type of ladle to use for important work, as hot, clean metal free from slag may be always ensured. The main point, however, in pouring operations is to be always able to control a constant stream of molten iron free from slag. In top-poured ladles this slag is a very real menace to the production of castings to be machined, and careful skimming cannot be too strongly emphasised. Any entrapped slag will cause blow-holes in the castings, and when any important casting is being poured very careful attention should be paid to this point, and every possible means taken to combat it. In ordinary hydraulic or similar work, where no projection in the mould may catch this scum (if any may find its way into the mould with the molten metal) an ordinary deep basin without plugs, using a top-poured ladle, may be used. In cylinder work, however, or any job with internal mould projections, a very deep basin is required, together with plugs and bottom-poured ladle. One very important point in the use of plugs is to see that they are a perfect fit in the runners. If they are not metal may leak into the mould, solidify, and, when the metal does enter the mould, not unite.

Pouring Temperature.

All high duty work should be poured hot. Pouring hot is essential, whether the casting be large or small, thick or thin, if the best work is to be turned out.

Lack of density in castings is due to casting at too low a temperature. This lack of density is due to either blow or shrink holes. In large castings foundrymen have often a certain fear of casting hot and allow the metal to stand. That this is a fallacy was brought home very forcibly in the writer's experience some time ago. A Diesel engine flywheel, of about 12 tons in weight, and having a section about 36 in. thick, had been cast on the cold side, and was badly drawn under the risers. Prior to this, one had been cast very successfully at a higher temperature. The first wheel had taken about 6 or 7 hours to feed. The second had only taken about 5 hours. Obviously the faulty wheel had taken less metal and had a lower density. If it had been cast hotter a sound

FIG. 14.—SAME CONDITIONS AS FIG. 13, BUT CAST COLD.

job would have been the result. The following experiment was carried out to see what was the result of casting cold and casting hot. Two identical blocks were made in dry sand moulds and cast with hot and cold metal from the same ladle. Figs. 8 and 9 show the blocks sectioned through the centre, illustrating blow-holes and lack of density. With regard to the top of the

sections, it will be noticed that the cold block has a perfectly straight top, whilst the hot cast one has shrunk.

Other differences between casting hot and cold may be found in the test results taken from different bars cast from the same ladle. It seems, from experiments that have been done, that there is some relation between casting temperature and the thickness of the casting, but the highest tests are inclined to be obtained with a casting temperature between 1,350 and 1,400 deg. C. Casting hot does not seem to increase the hardness nor the chilling effect as much as some people think. Figs. 10, 11 and 12 show the depth of chill obtained by casting hot and cold, together with the Brinell hardness from the edge to the centre of a 3-in. square block cast in dry sand. Figs. 13 and 14 are microphotographs showing the structure obtained by casting hot and cold.

Behaviour of Burden in Blast Furnaces.

Many erroneous ideas prevail in regard to the behaviour of the burden in the blast furnace, judging by the various diagrams published even recently in technical papers, and hence PROF. E. DIEPSCHLAG, of Breslau, in a recent issue of "Stahl und Eisen," attempts to throw some light on the subject.

The burden in the blast furnace consists of ore in pieces of varying size and composition, and coke heaped in alternating layers. Now, owing to the disparity in the size of the pieces forming the burden, the upward flow of gases is more or less irregular. At each level there are places through which the bulk of the gases flow at a high rate, giving off heat to the burden, while at other points the rate of flow is much less, and the flow of the gases may even be checked altogether. It is at these latter points that the chemical reactions take place principally, viz., the reduction of the iron oxides and—at temperature zones between 300 and 800 deg. C.—the separation of the carbon. As the burden settles down lateral displacements gradually cause the principal gas channels to contract or close up altogether, and the gas is compelled to find fresh paths. Every time a certain zone of material sinks down quantities of fine constituents are carried with it, so that at these moments great quantities of flue dust are formed. In some places the heating becomes more intense, while in others the flow of gases comes to a standstill and the reactions already referred to take place. Due to this irregularity of flow and heating the composition of the gases varies considerably at different places of the same cross-section of the furnace, and this explains why the results of analyses of gas samples taken depend on chance. The measurement of temperatures in the several parts of the furnace is also apt to be misleading, because at these points the concentration of carbon dioxide may vary considerably, according to whether the places at which the measurements are taken are free to the flow of the gases or their flow is retarded.

In the lower regions of the furnace thus there may be portions of the ore charge that have been very little exposed to the action of the gases, whereas in certain parts of the upper region the reactions may have already made considerable progress. It is quite wrong, therefore, to divide the several zones of reaction into horizontal divisions of the furnace profile, as is generally done. To get a satisfactory working of the furnace the burden must shift about as much as possible in order to change as frequently as practicable the direction of flow of the gases.

The settling down of the burden as it appears at the throat is not a steady movement, but is always spasmodic, and this the writer attributes, not to the formation of "arches" or "scaffolding," but is due to the pressure of the superincumbent burden. The burden is not held up by the bosh, but rests mainly on the base of the furnace, and is only partly supported by the walls. Due to the melting of the ore and the combustion of the coke, the base of the tall and heavy column of burden, weighing about 500 tons, is gradually weakened at the level of the tuyeres. Finally the lower portion fails to support the heavy superincumbent weight and collapses until, with the further settling down of the burden, the bottom portion is able again to afford sufficient support to the column. This process, occurring at regular intervals, explains the spasmodic sinking of the burden. It also explains why the amount of heat required in the zones of combustion and smelting continually changes. It is possible to overload the lower portion of the column prematurely by suddenly shutting off the blast.

In each cross section of the upper part of the burden there are zones in which the current of heating gas gives off its heat, while in others the chemical changes principally take place. These reactions, in conjunction with the separation of the carbon, break up the ore and consolidate the material of the column. The channels of flow of the gases are consequently reduced in area, and there is a danger of this zone spreading upwards, because the exothermal reaction of the separation of the carbon tends to heat the part of the burden immediately above. If for any reason this process does spread to any extent there is less chance of such zones being accessible to the current of heating gas. In the course of normal working they are always broken up by the spasmodic sinking of the burden. But should they spread the gas passages are gradually blocked up and the resistance to the flow of the gases is increased, which is immediately observable by an increase in the blast pressure. By shutting off the blast the burden is made to collapse, and the compact column of the material being loosened, new passages are opened up for the gases. If, on the other hand, the column does not collapse, the consolidation of the burden quickly proceeds and overheating takes place, due to excess exothermal reaction resulting from the separation of the carbon. At the same time the blast taken up by the furnace diminishes in volume, but increases in pressure.

This phenomenon, commonly termed (in English) "hanging" or "scaffolding," is really a consolidation of the burden, and would be better so named. If repeated shutting off the blast does not get rid of the trouble, the only remedy suggested by experience is to use cold air for the blast, as this chills the burden and makes it shrink. At the same time a large volume of carbon dioxide is produced in the lower part of the furnace which checks the separation of the carbon. This remedial measure is often accompanied by explosions and the violent ejection of large quantities of material from the furnace throat. This phenomenon, which often lasts a long time until the furnace is brought to a state of quiet working again, is due to the fact that, in the lower part of the furnace, only a moderate combustion of the coke takes place even though the burden has practically become impermeable to gases. The gases of combustion generated escape through the joints of the furnace masonry, the amount depending upon the blast pressure. When the lower portion of the column is no longer able to support the weight of the burden it collapses, and large quantities of fine material, consisting of particles of ore and carbon, flow upwards into the hot smelting zone, surrounded by reducing gases of high carbon dioxide concentration. Owing to their sudden heating the CO_2 particles combine with the fine carbon and form carbon monoxide, with a doubling of the volume according to equation $CO_2 + C = 2\,CO$. The enormous gas pressure ejects a portion of the burden from the furnace throat. In this way more and more carbon and CO_2 get into the hot smelting zone, and the reaction continues for some time. It will be seen, therefore, how erroneous it is to use the term "hanging of the charge" for what is really a consolidation of the upper part of the burden.

If after blowing out the furnace and clearing out the remaining burden any scaffolding is found it is quite possible that this has been formed after the furnace has stopped working. The furnace after it has been blown out is cooled with jets of water, which slakes the lime in the burden and causes it to swell; the lime thus slaked binds together the burden and forms the vaulting or scaffolding to be found when the burden remaining in the furnace is cleared out.

XUM

The Selling of Castings.—V.

By VOYAGEUR.

Sales campaigns cover the use of every known method of selling the product, following closely the lines of any policy previously laid down. They can be described as detailed schemes of operations. It should be thoroughly understood that it is just as necessary for the small founder to have a properly organised selling campaign as for the large founder. In fact, it is even more necessary, because the former can less readily afford to squander his money on unsatisfactory selling activities, less easily bear the brunt of failure. The sales campaign's chief aim is to obtain maximum sales with the minimum of delay and cost. As indicated in the previous article, sales campaigns are divisible into those of a general and those of a special character. The general sales campaign is the subject of the present article, and therefore consideration of the special campaign will be left for a time.

General campaigns cover the recurring, day-to-day selling activities, *e.g.*, circularising, advertising, salesmen, etc. When a founder prepares a general sales campaign, he is committing himself to a regularisation and unification of all his usual selling plans. And, of course, the starting-point for any such preparation is a decision of the amount that can safely be spent. This decision is difficult to attain, because so many conflicting factors enter into any discussion centred on it, but in practice it will be found advisable to allot a specific sum for selling costs, this sum covering a defined period, usually a year. How large this sum shall be must largely be governed by the character and history of the castings. If well established on the market, less will be needed than if they are new to it. Some founders allow 10 per cent. of their total profits for selling costs; some reckon their sum by allowing a certain percentage of the annual turnover; others take the final costs of production and add a percentage to these. But all these schemes are more or less arbitrary, and in most instances no scientific means exist of deciding whether the relation the selling costs bear to profits, turnover, or production costs is adequate or otherwise.

There is only one safe method of allotting a definite sum to selling, and that is to calculate as closely and soundly as possible the exact sum needed to execute the sales policy. Salesmen's salaries are known; the publicity manager can estimate the amount and cost of advertising he considers necessary to cover a particular ground, as recommended by the policy; the sales manager knows the salaries of his staff; and, in short, all the projected activities can be considered beforehand and an estimate of their total cost arrived at. This estimate can then be submitted to the board of directors as the suggested figure for selling costs, and it is up to them to accept the figure or modify it as they think fit. If they cannot safely sanction the recommended expenditure, they will say so, and then the sales manager will have to reduce the scope of his campaign correspondingly. It must be remembered that an ambitious campaign cannot be carried out without adequate funds.

When the total allotment for the year has been fixed, the next problem is to apportion it among the various branches of marketing. Thus, money will be needed for advertisements, circularising, salesmen, exhibitions, and so forth, and a margin must be left to cover emergencies, such as an unforeseen opportunity presented to reach a particular market, *e.g.*, the production of a casting reaching an uncovered market, or the opening of an unexpected exhibition.

Having apportioned the selling costs among the various branches, operations must next be begun in real earnest. There are seven forms of selling, with all of which the founder will probably have to familiarise himself. These seven are as follows:—Selling by salesmen, by advertising, by circularising, by catalogues and other literature, by trade or technical exhibitions, by means of overseas agencies or branch offices, and through retail shops or stores.

The salesman is the one member of the selling staff who actually rubs shoulders with the users of the castings, and this gives him experience and insight that can prove of great value to the manufacturer. He is a link between founder and user, and endeavours constantly by his personal efforts to improve the relations between his employers and those who buy their goods. He serves as intermediary in overcoming little troubles; gathers in his interviews information of use to the foundry that might not otherwise be obtained; states the user's position succinctly to the foundry and its management, and, in brief, is a reliable negotiator wherever tact and discretion are needed.

Advertising is a factor of the utmost importance in selling castings, though its significance is not yet estimated at its proper value by foundry proprietors. Its purpose is to disseminate facts about the castings and their makers; to indicate why they should be bought in preference to those of competing makes; to create goodwill for the foundry; and to cover instantaneously ground that would need an army of salesmen to explore it.

Circularising is another selling factor of extreme value. Its virtue is that it puts the arguments in favour of the castings cheaply and economically before buyers of all classes. It does not do exactly the same work as advertising, but can be regarded as a useful ally to it. It is not continuous, as advertising is, but it can be timed to suit particular occasions or opportunities, and is thus extremely powerful in its selling value.

Selling by means of printed matter includes the provision of good catalogues, brochures, leaflets, and so forth, the aim of which is to state clearly and well the character of the castings, the varieties and sizes in which they can be obtained, their purpose and price, wherever these can be stated. Literature of this kind recounts in a more specialised and intimate fashion than either advertisement or circular all that matters about the goods and the firm that makes them.

Exhibitions have two great advantages. They bring buyers from overseas, and they catch these buyers in a real buying humour. A cleverly arranged exhibit is quite likely to draw the attention and arouse the interest of some person who has refrained from placing orders until he has seen the very latest goods on the market, at some local or national exhibition, and this may lead to good business of an extensive character.

The labours of overseas agencies and branch offices concentrate on increasing the fame of the founder in countries abroad, and on suggesting or devising means of ensuring a ready sale for the castings in their own particular markets. This may even take the form of variations in the selling policy, designed to suit the particular country affected.

Of course, it is not every kind of casting that lends itself to distribution through retail shops, but it sometimes happens that founders will have to take this selling factor into account in their selling policies and campaigns, especially where the casting is a standard object of use either to the general householder or to the small engineer who purchases through the local hardware shop.

It has been possible in this article to touch but lightly on the seven forms of selling activity, but closer attention will be paid to them later. One must now turn to a consideration of the special sales campaign, by no means a negligible matter in scientific marketing.

Catalogues Received.

Metal Melting Plant.—Messrs. George Green & Company, foundry engineers, of Keighley, have just prepared an eight-page illustrated folder detailing the features of the cupolas, converters and tilting crucible furnaces which they manufacture. Steel ladles are also included.

Cast-Iron Pipes.—The December stock list of the Staveley Coal & Iron Company, Limited, of Chesterfield is now available to the trade.

Foundry Sands.—Mr. Algernon Lewin Curtis, of Westmoor Laboratory, Chatteris, has prepared a 24-page catalogue dealing with the various industrial uses of sands. The major portion of the book is devoted to metallurgical requirements, and will prove of considerable interest to the majority of our readers.

The Analysis of Grey Iron Foundry Alloys.—XI.

By H. H. S.

Titanium in Cast Iron.

This element is often found present to a small extent in many pig-irons, but owing to lack of knowledge as to the effect of titanium upon cast iron, its determination rarely if ever forms part of ordinary analytical procedure, its presence being more often than not ignored. Moldenke found that small additions of titanium—not exceeding 0.05 per cent. in the metal—increased the breaking strength, hardness and compression values of grey cast iron. This investigator and others attribute the benefits derived from titanium additions to de-oxidation of the iron, owing to the great affinity of titanium for oxygen. It is interesting to note that practically the whole of the metal added passes into the slag. Though Moldenke's results may not entirely warrant the general adoption of adding titanium to grey iron, they do certainly indicate a direction into which research and practical investigational work may be very profitably turned.

It is not improbable that such work and the detection and estimation of the presence of small amounts of de-oxidising and de-nitrogenising elements like titanium may lead to a scientific explanation of the so-called "inherent" properties of pig-iron.

Below is set out an accurate method for detecting and determining titanium in cast iron. When the iron contains more than 0.3 per cent. of phosphorus, any titanium present forms an insoluble compound with the phosphorus and iron, when the metal is treated with HCL; hence it is precipitated with the silicon and graphite. This enables the detection and determination to be carried out on the residue resulting from a silicon estimation, provided that the latter is determined either by the hydrochloric acid or aqua-regia methods as described in Article III, and that a 3-gramme sample is employed. The following variations from the normal method of procedure must be noted:—

(1) Treat the sample with 60 c.c. of concentrated HCL; (2) bake for fully 30 minutes; (3) add 50 c.c.s. conc. HCL to affect solution of the baked salts; (4) dilute with 50 c.c. of H_2O before filtering; (5) wash graphite and silica at least three times alternately with hot dilute HCL and H_2O, and finally twice with H_2O; (6) if the platinum crucible is small it is advisable to dry filter and residue in a porcelain crucible first, then transfer to the former; (7) ignite the residue to burn off the carbon, then weigh ignited residue and the crucible; (8) treat residue with 3 c.c. H_2SO_4 (1 to 1) 2 c.c. H.F. and about three drops of conc. HNO_3. Evaporate slowly to dryness, and ignite for 5 to 10 minutes; and (9) silicon percentage equals difference in weight between first and second weighings × 47 ÷ 3.

Estimation of Titanium.

Solutions Required.

Strong Standard Solution of Titanium.—Weigh 0.125 grms. of pure titanic oxide (T_iO_2) and fuse with ten times its weight of anhydrous sodium carbonate, contained in a platinum crucible. When fused, place the crucible and its contents in a small beaker, add about 15 c.c. of H_2SO_4 (1 to 1) and boil. When the residue is completely detached from the crucible, wash out the latter with a little dilute H_2SO_4 and hot water and boil the residue and liquid until the sodium titanate passes into solution. The solution is cooled and transferred to a 250-c.c. calibrated flask, and diluted to the mark with dilute H_2SO_4 (1 to 1). A little care is required in preparing the stardard solution, otherwise difficulty will be experienced in dissolving the sodium titanate. One of the first essentials is to fuse well. Each c.c. of the above solution is equivalent to 0.01 per cent. of titanium on a 3-gramme sample.

Dilute Standard Solution of Titanium.—This solution is only required where extreme accuracy is necessary, and it should be made as required just prior to an estimation; it is prepared by diluting one volume of the stronger solution with dilute (1 to 3) H_2SO_4 to 10 volumes. Each c.c. will then be equal to 0.00003 grm. of titanium or 0.001 per cent. on 3 grms.

Sodium Peroxide Solution.—Sprinkle 4 grms. of sodium peroxide into 125 c.c. 1 to 3 H_2SO_4, and when the salt is dissolved, dilute the liquid to 500 c.c. Keep in a brown or blue glass bottle, well stoppered and away from strong day or artificial light.

Apparatus Required.—A simple apparatus and one which the writer has found very efficient is that devised and recommended by the chief chemist of the Titanium Alloy Manufacturing Company of America. As will be seen from Fig. 1, the colorimeter consists of a rectangular block of wood having approximate dimensions of 2¼ × 4 × 7 in. high, the height being about 1 in. below that of the Nessler tubes. Through the block are bored two holes of diameter just sufficient to receive the tubes. The base of the apparatus should be about ¼ in. to ⅜ in. thick and have two holes bored concentric with the holes in the block, but the former holes should be about ¼ to ⅜ in. less in diameter than the latter, so that a ledge is formed to carry the tubes, as indicated in sketch.

To prevent shadows and give better illumination the holes in the base should be bevelled outwards to an angle of 45 deg., and for the same reasons the holes in the block are painted dead black.

Nessler Tubes or Glasses.—A set of two, four or six glasses will be found convenient; they should be of 50 c.c. capacity and marked. The more

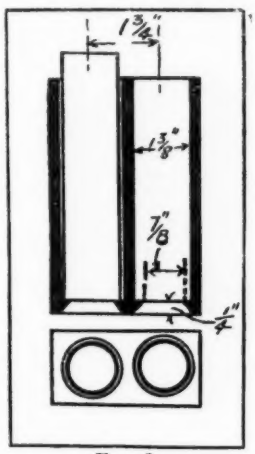


FIG. 1.

important points in regard to the purchase of these glasses are to make sure that all those in the set are of the same dimensions as the tube adopted for the standard, especially in respect of thickness, and that the glass is colourless or very nearly so. If they are slightly coloured (usually green or pink), then the colour should be uniform in intensity throughout the set. It is advisable to test the tubes as to colour by adopting one for a standard, filling it to the mark with cold distilled H_2O and placing it in the colorimeter, the latter being placed on a white tile. The other glasses are then filled with water and compared to the standard tube; if they reflect coloured light, they should be rejected, unless, of course, the reflected light is of the same colour and intensity as the standard tube. It is advisable to have two burettes, one for the standard solution and one for distilled water. Ordinary 50-c.c. burettes will do.

The Estimation.—Treat the residue remaining in the platinum crucible after the determination of the silicon with 2 grms. of potassium bi-sulphate, fuse carefully at red heat, cool and boil out the residue with a little H_2SO_4 (1 to 1), keeping the bulk below 30 c.c.s. The cooled solution is then transferred to one of the Nessler tubes and diluted to about 45 c.c.s. with cold H_2O. To the standard tube add the same bulk of H_2O, then

place both tubes in the colorimeter, the latter being placed on a white tile as before. If the sample solution shows a yellowish colouration—which should not be if the treatment in the silica estimation has been properly carried out—add a few drops of an iron solution to the standard tube, until, after well stirring, it compares with the sample.

A 3.0 per cent. solution of ferric ammonium sulphate is recommended as the iron solution, and it is preferable to add it from a dropping bottle or pipette, so that the amount added can easily be controlled.

If it is found unnecessary to add any ferric solution, the solutions in both tubes are diluted to the 50 c.c. mark with H_2O, if the standard requires to be adjusted to the colour of the sample in the manner indicated, the dilution to 50 c.c. is made after the adjustment. Two c.c.s. of sodium peroxide solution is now added to each tube. The minutest quantity of titanium is at once shown up by the development of a yellow colouration in the sample solution. If such a colouration is produced, stir gently with a thin glass rod. From the burette add standard titanium solution, a few drops at a time, and stirring, to the standard tube, then add the same volume of H_2O from the other burette to the sample tube, so that the volumes are kept equal. Continue the addition of titanium solution and H_2O to their respective tubes until they match each other in colour when compared in the colorimeter. To secure the most accurate results, the tube should be interchanged from right to left in the colorimeter in the same way as has already been described for the colorimetric method of the determination of combined carbon in cast iron. Having brought about matching of the colours, the amount of titanium solution used is noted, and from the reading the percentage of titanium is at once known according to the percentage factor of the standard solution used.

It may be of interest to record a gravimetric method of determining the quantity of titanium in ferro-titanium or ferro-carbon-titanium, which is also recommended by the Titanium Alloy Manufacturing Company, and which has been found by the writer to give reliable results: Weigh 0.6 grms. of the finely divided alloy into a casserole as used for silicon determinations, add a mixture of acids comprising 15 c.c. H_2SO_4 (1 to 1), 10 c.c. HCL (conc.) and 5 c.c. HNO_3 (conc.), cover the casserole with a cover glass, heat gently at first to effect decomposition, and then evaporate to fuming as in Drown's method for silicons. When cool add 10 c.c. HCL, heat to boiling, then add 50 c.c. H_2O and boil until solution of the salts is complete. Filter through a "40" paper and wash with HCL and H_2O, as for silicon; throw away residue, collect the filtrate in a 400-c.c. lipped beaker, and slight excess of NH_4OH to precipitate iron and titanium, and warm—do not boil—to aid settling of the precipitate Filter through a No. 1 (Whatman) paper and wash the precipitate twice with hot H_2O. Discard the filtrate, dissolve the precipitate with the least amount of dilute HCL (hot). This is best carried out by making a hole in the filter paper, washing the precipitate through with a fine jet of hot dilute HCL, and washing the paper well with hot H_2O. If necessary, warm the solution to completely dissolve the precipitate; nearly neutralise with NH_4OH, dilute to 300 c.c., and pass a rapid current of sulphur di-oxide gas through the liquid for about 10 minutes, or until the solution is saturated. Boil the solution until the titanic acid is precipitated and the solution smells only faintly of sulphur di-oxide (SO_2). Allow the precipitate to settle, then filter through a "40" paper and wash with dilute sulphurous acid and water. Transfer filter paper and residue to a porcelain crucible, dry, ignite, brush out the oxide, or re-weigh the crucible if it was weighed in the first instance. Each 0.001 gramme of Ti_1O_2 is equivalent to 0.1 per cent. of titanium.

THE LANARKSHIRE MIDDLE WARD DISTRICT COMMITTEE, at Glasgow, have decided to build 100 of Lord Weir's steel houses at a cost of £375 each. It was stated this would permit the charging of rents to meet working-class wages.

The Allocation of General Expenses.*

The Belgian Commission appointed to consider manufacturing costs has recommended that overhead expenses should be divided into sectional costs and general expenses, common to all orders, or general cost of administration. For the division of costs of the second order two methods have been put forward:—(1) Allocation according to the total cost of manufacture (metal + wages + sectional costs) for each order. (2) Allocation among the different divisions proportionately to the wages in each division; then, in each division, proportionally to the extent to which other salaries are engaged in each order.

The authors of this Paper propose a method that embraces both of the above methods. General expenses are distributed among the different sections proportionally to the total wages and salaries; producers and non-producers, the melting, too, forms part of the charges in question. The findings of the Belgian Commission are accepted with regard to the first category, so attention is directed to the second category. There are two ways of dealing with the question:—(1) Division proportionately to productive wages, as is done in the case of sectional expenses. (2) Division according to the total manufacturing cost of each order, salaries, sectional expenses, metal and material from stores, or according to selling price. Some notes from the reports of various firms are given in brief.

On the making of medium castings the manufacturing cost of castings of 200 lbs. and over was considerably burdened by the application of the new method, but the lighter castings benefited. The result was large orders for light castings of 100 lbs. or less, but no orders for castings above 200 lbs. The firm naturally decided to revert to the first method. A large manufacturer of medium-sized castings in ordinary iron found that the manufacturing cost of work in hand came out so high that the majority of current orders were finished at a loss; at the same time the profit from special castings increased. In this case also the new system was given up.

Continuing its researches, the Belgian Commission was led to alter its point of view, and in 1923 reported: "The overhead charges, or expenses of administration, are first distributed—between the different sections—according to the proportion of the productive wages of each section to the whole. Distribution being made, the general sectional charges are added to each section respectively. Dividing the total obtained for each section by the direct wages, the percentage of expenses is obtained which is to be carried by each hundred units (say shillings) of productive wages in each section."

"Taking into account the suggestions and information gathered at the congresses at Liège and at Nancy, and after consulting a number of authorities on the question, we consider that the present system of distribution is the most logical and is the most suitable to meet the demands for increasing accuracy in the foundry accounts."

In this system of distribution, however, there arises the question, "Are the general expenses really proportional to productive wages?" Is it right that only the wages of patternmakers, moulders and coremakers should be burdened with general expenses? It is certain, for instance, that several posts are influenced by the number of workmen; it is certain, too, that in the term "general expenses" are included some that do not appear in the assessment of manufacturing costs of the metal, such, for example, as the book-keeping in the stores, gatekeepers, etc. Is it logical to burden the wages of patternmakers and moulders with these charges?

It is considered more equitable to distribute general expenses over the whole of the wages and salaries, productive and non-productive. The object is to lighten the burden on those sections which make modest demands only on the activities of the non-productive element and to allocate a portion to the operation of melting.

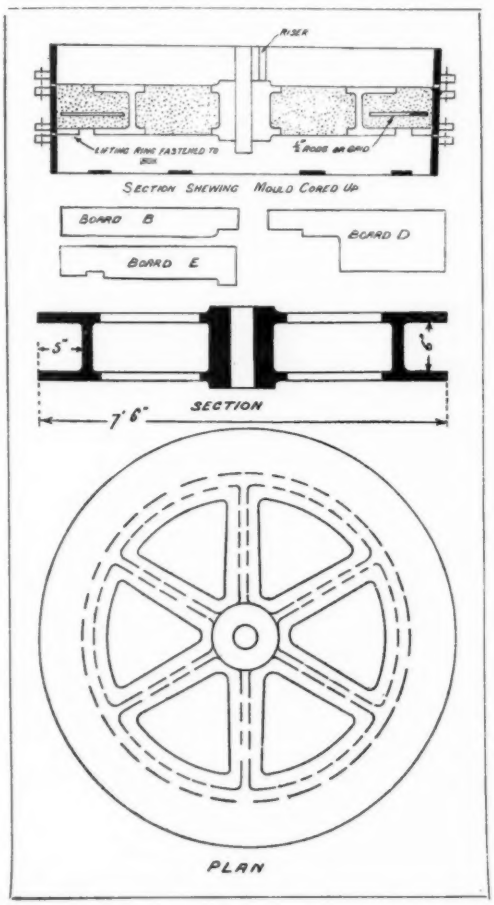
* Translation of the Report presented by the Belgian Foundrymen's Association to the 4th Annual Congress of the Association Technique de Fonderie.

Moulding a Guide Pulley.

BY J. H. LIST.

Often in jobbing foundries one casting only is wanted, and the cost of even part patterns is a very expensive matter. This article deals with such a case, and describes a method of sweeping up a haulage pulley of a guide pulley. This class of wheel is in constant use, but so far as the writer's experience goes there are seldom two just alike. In itself and in the hands of a good patternmaker and a good moulder sweeping such a wheel is fairly simple. There are several ways of handling such a job, but perhaps only one straightforward and simple method. A standardised method would be a great help to all concerned, particularly the patternmaker who could get straight to work without first having to discuss details with the moulder, and, furthermore, the moulder would get accustomed to the shape of the sweeping boards.

It will be seen by the plan and cross section (below) that it has six arms of an H-section.



The arms are all formed by a core, and, apart from the boss core, it is the only box needed. These cores are made in dry sand very easily, and the core box is also quite a simple job.

Sweeping Boards.

The job is started from the top box, and is worked downwards, the job being made in a three-parted box.

After putting on the middle part and sweeping out a false middle, as indicated by sweeping board B, make a parting joint, and place on the top box. The box is well rammed up and vented, the downrights and risers are cut and the box lifted off. This may be finished off and taken to the drying stove. It will be seen this will form the top boss of the wheel and upper webs of the arms and rim. Cut out a hole in the centre to clear the core when assembling.

Next dig away for the depth of the wheel all round and fix in the C.I. lifting ring as shown shaded. Attach sweeping board C, and sweep out the top side of the core of the groove. This will be a flat board. As a portion of the core is overhanging, it is necessary to insert rods about ½ in. dia., or a grid to carry this overhanging portion as shown. To form a backing to ram against the false centre is left in, but after the top surface of this core is finished, the false centre is dug away and another sweeping board, D, is placed in position, and the core then finished off. It will be noticed the round or fillet on the bottom edge of the groove core must be put on as the strickle board cannot do this.

It is necessary to vent to the edge of the box and upwards into a common channel. The middle part, with the ring removed, can now be lifted off. The core portion may then be washed with a plumbago mixture and taken into the drying stove.

The bottom part is started by digging it nearly all out and ramming up again with facing sand, the strickle board E is fixed up, the bottom forming the boss swept out, together with the lower portion of arm and groove as shown. The sweeping board marks out the boss core position. The bottom part can be now well vented and the runners finished off, taking care that they correspond with the ones cut in the middle and top part. A common channel is cut, and all round the joint of this part is vented, the vents being led to the box edge.

This part now needs sleeking and drying in the stove. When all three parts are dry the mould may be assembled. On fixing the bottom it is necessary to ascertain that the bed is so made that it can easily be vented from underneath, and that the joints between the box parts are making good contact, before finally clamping up.

The middle part, on replacing, will act as a guide for the fixing of the cores forming the arms. Next place in position the arm cores. It will be observed that there are no prints provided for these, and that they can be moved about at will. It will be necessary, therefore, to see they are equally spaced, or the arms will be of unequal thickness.

The centre core, which is next inserted, should be long enough to come right up through the top box. In placing the top box into position care must be taken not to foul the centre core, which will want making up well by first placing in some loose hemp and making good with sand. This will leave some flash, but "better a flash than a crush" is a foundry axiom.

After clamping the parts well together, the runner bush, consisting of one long bush and runners leading to other four positions is added. A large riser is taken off the centre boss, which will require feeding.

Catalogues Received.

Concrete-lined Iron Pipes.—The Stanton Ironworks Company, Limited, have just issued a beautifully illustrated 12-page catalogue describing the advantage accruing from the replacement of ordinary cast-iron pipes by those which have been centrifugally lined with concrete. For districts provided with a peaty or soft water supply, such pipes are of special interest.

Metallurgical Service.—"Chemist and Founder" is the title of a 12-page booklet which Beecroft & Partners, Limited, of St. Peter's Close, Sheffield, are circularising to the foundry trades. Its object is to describe and illustrate the service they give and the specialities they have developed for the better conduct of foundry operations. It has a particularly pleasing get-up, and we understand it will be sent to any foundry on request.

Cupolettes.—The Constructional Engineering Company, Limited, of Charles Henry Street, Birmingham, have struck a new note in their latest pamphlet dealing with their well-known cupolette. It takes the form of an illustrated letter form. We understand that it is mainly for export houses and foreign trade generally, who require a plain story told in plain language. The pamphlet has well met these requirements.

XUM

Aluminium Alloy Castings from Sheet Scrap.*

By HORACE C. KNERR, Philadelphia, Pa.

The purpose of this Paper is to outline the methods by which a very small foundry, started on an experimental basis, succeeded in meeting the requirements for sound and dependable aluminium alloy sand castings, only scrap aluminium sheet and copper available at the factory being used.

The castings in question are required to meet Government specifications corresponding approximately to the well-known commercial alloy No. 12. The composition was copper, 7.0 to 8.5 per cent.; impurities, 1.7 per cent. max.; and aluminium remainder.

The physical properties were:—Specific gravity, not over 2.89; tensile strength (min.), 7.1 tons sq. in.; and elongation in 2 in. (min.), 1.5 per cent.

These castings are used chiefly for small, moderately stressed parts of aircraft and their accessories, such as pulleys, brackets, portions of the control mechanism, parts of fuel and oil pumps, threaded fittings and connections in gasoline tanks and lines, etc. In fuel lines, non-porosity is essential, and the fittings are required to withstand an air-pressure test of 10 lbs. per sq. in. without leakage, and must be capable of welding to commercially pure (99 per cent.) aluminium sheet and tubing. (Where high strength and lightness are required, special heat-treated commercial aluminium alloy castings are purchased.)

Much difficulty and annoyance were experienced in attempting to obtain castings from outside sources to meet these moderate requirements. A large proportion of the castings received were exceedingly porous, spongy, and unreliable in strength. Many of them had inclusions of foreign matter which interfered with machining and caused weakness. Delay in delivery, high charges per pound in small lots, and the cost of the paper work incidental to purchase, were further objectionable features. It was therefore decided to attempt to produce the required castings within the plant, although no foundry work had hitherto been done there.

First Experiments.

The work was undertaken on an experimental basis. A small, second-hand oil-fired tilting brass furnace was obtained, flasks and a moulder's bench constructed, and moulders' tools and a ton of medium fine Albany sand was purchased.

Melting was at first done in graphite or plumbago crucibles, but the results were unsatisfactory, presumably on account of the access of furnace gases to the molten metal. A pot was therefore made of welded steel sheet and tubing, which completely excluded furnace gases from the metal. A pronounced improvement resulted, and this was in fact the first step in obtaining sound and satisfactory castings. Although intended for experimental use only, the original pot is still in service at the time of writing, after more than 100 heats, having been repaired several times by welding.

Examination of the interior of the pot after months of use shows very little attack, and it is evident that little or no iron has been taken up from it by the aluminium. No protective coating was used, inside or out. Repairs, or a new bottom, were necessary on account of failure of the welded seam, or by burning through from the outside where in contact with the flame. It is intended to replace this pot by a cast-iron pot, to avoid welded seams.

Porous Scrap Castings Unsatisfactory for Remelting.

It was at first attempted to produce the required castings by remelting scrap aluminium alloy crank cases and similar parts from aircraft engines. These castings were of practically the same composition as called for, but were for the most part very porous. They did not produce sound castings when remelted.

A quantity of 99 per cent. aluminium pig was purchased, and the requisite amount of copper added in the form of chopped copper sheet, tubing and wire from the scrap bins. A high percentage of the resulting castings still had to be rejected for porosity.

A considerable quantity of 99 per cent. aluminium sheet scrap was available in the plant from the manufacture of fuel tanks, cowling, and other parts for aircraft. Remelting this scrap, with the addition of scrap copper sheet and tubing gave the best results which had so far been obtained. The use of other materials was therefore discontinued, there being ample sheet scrap available to meet the needs of the foundry. The sheet and tubing from which the copper scrap was obtained was purchased under specifications calling for 99 per cent. purity. By carefully sorting all scrap to eliminate other metals, freedom from excess impurities in the castings was reasonably well assured.

Temperature Control.

From the beginning, the need for accurate temperature control was recognised. It was found that there was a strong tendency on the part of the foundrymen to overheat the metal, which invariably resulted in porous castings of inferior strength. A portable pyrometer of the potentiometer type was provided, connected with an iron-constantan thermo-couple. The latter was encased in a sheath made of seamless steel tubing, 1 in. in diameter, with a 1-16 in. wall, closed at the bottom by welding.

Present Practice.

The couple is allowed to remain in the bath, and the temperature is observed constantly, from the time melting begins until ready to pour.

When ready to melt, the pot is preheated to a dull red (about 700 deg. C.), and gates and risers from previous heats to the amount of about 50 per cent. of the charge are added. When these are melted, the sheet aluminium scrap is added, as fast as it will melt. While there is unmelted metal in the bath, the temperature remains constant at about 650 to 675 deg. C. If the unmelted scrap becomes stuck in the upper part of the crucible, the liquid metal at the bottom may easily become overheated, as heat is added rather rapidly during melting. Moreover, unless the end of the thermo-couple is immersed a distance of at least 6 in., it is likely to give low readings. Special care is therefore necessary to prevent overheating during melting. The sheet scrap is, of course, carefully weighed before charging. When the aluminium is fully melted, the temperature is raised to about 730 deg. C., and copper scrap is added in small pieces. Being of thin section, the copper scrap dissolves rapidly in the aluminium. The melt is stirred with an iron rod until the copper is completely dissolved and the melt thoroughly mixed. The metal is then allowed to stand for two or three minutes, and is skimmed.

The metal is now fluxed with zinc chloride (commercially pure), using about 1 oz. per 100 lbs. of metal. The salt is placed in a small cup formed in the end of an iron rod or tube, thrust to the bottom of the molten metal, and stirred until the reaction is completed. The metal is again allowed to stand for a minute or two, carefully skimmed, and then immediately poured. The pouring temperature is held between 720 deg. C. and 750 deg. C.

Hand ladles of thin, pressed steel, previously preheated, are used to transfer the metal from the pot to the moulds.

About one to one and one-half hours is required from beginning to melt until ready to pour. A melt generally consists of about 150 lbs. of metal, the minimum being 100 lbs. On account of the small size of the castings, about 50 per cent. gates and risers are produced.

Moulds are required to be ready when the metal is melted, so that the metal will not be held longer than necessary.

All moulding work is done by hand, no mechanical equipment being available. Ramming is light, the work is plentifully vented, and risers are used freely. The sand is kept as dry as practicable.

Core Oven.

Much difficulty was at first experienced through the unsatisfactory drying of cores in a makeshift core oven. An electrically heated oven was con-

* Extract of a Paper read before the Milwaukee Meeting of the American Foundrymen's Association.

structed of sheet metal, insulated with magnesia boiler covering, and provided with adjustable vents at top and bottom to insure circulation of air. This furnace requires very little regulation or attention, and the results have well repaid the cost of its construction.

Cores are made from the same sand as is used in moulding, with the addition of a commercial binder.

Test Bars.

Inspection of castings for physical properties, porosity, and defects is rigid. Three tensile test bars are cast with every heat, one being poured respectively from the first, middle and last ladle. Each is poured with a separate gate and riser. They are tested as cast, without machining.

Two types of coupons have been used. These bars are cast to size and are not machined.

Tests.

Castings which are to be used in gasoline lines are tested for porosity or leaks by closing all openings with the aid of rubber gasketed clamps and injecting compressed air at a pressure of 10 lbs. per sq. in., with the casting immersed in water.

As is well known, this alloy has a persistent tendency to porosity, even under the best conditions. About 20 per cent. of the castings tested show leaks, but the leaks are generally confined to small pinholes. Such castings may be salvaged by impregnating them with sodium silicate, which effectually seals them, and does not interfere with subsequent welding or other operations. This treatment is applied, if necessary, after final machining, and the porosity test is then repeated. Castings which have large leaks, permitting free bubbling of air, are remelted. Such cases are few. Rejections for failure of test specimens to meet physical requirements amounted to 7 per cent. of the first 100 heats poured. These rejections were mainly due to slightly low tensile strength caused either by overheating of the melt, by failure to mix the solution thoroughly, or by contamination of the scrap with other material, and were in the majority of cases traced to careless operation. The tensile test results of the first twelve heats showed on an average 9 tons per sq. in. associated with a 2.2 per cent. elongation. Flaws, blowholes or inclusions in the metal are rare.

Inspection.

A shop inspector is detailed to the foundry when heats are poured. He checks the weights of metal used, takes temperatures during melting, sees that test coupons are properly poured, identified and delivered for test, inspects castings on the foundry floor, and reports any difficulties or irregularities. Heats are serially numbered, and every casting is marked with its heat number for future identification. The foundry inspector keeps a record of each heat, and forwards duplicate copies to the chief inspector and metallurgist. Test bars are pulled within 24 hours, and the results approved before the castings are released to the shop.

Summary.

To avoid the delays and difficulties experienced in obtaining, from outside sources, sound aluminium alloy castings of the commonly used commercial grade, 8 per cent. copper, 92 per cent. aluminium, a small foundry was established in a plant where no foundry work had hitherto been done. Only scrap aluminium sheet and copper sheet, tubing, etc., available at the plant, were used. Satisfactory results were obtained through careful temperature control, exclusion of furnace gases, and other simple precautions. The production of aluminium alloy castings of good quality from sheet scrap was found entirely practicable.

THE EXECUTIVE of the Central Ironmoulders' Association, in their quarterly report, state that, in consequence of a further improvement in trading conditions in the light castings industry, the number of members unemployed has been reduced to slightly less than 2 per cent. The average, it is added, has now been brought to the level of times when it was considered that trade in the industry was exceedingly brisk. At the end of 1921 there were 1,500 unemployed members on the books of the Association; at the present time there are only 150 members unemployed.

Semi-Steel.

Writing on the above subject in the "Purdue University Bulletin," MR. G. W. GILDERMAN (superintendent of foundries, Dodge Manufacturing Company, Mishawaka, Ind., U.S.A.) remarks that "semi-steel" is a term little understood. There are still a few foundrymen who are under the impression that it is merely a close-grained iron. As this metal is made to-day, however, it is well worthy of its name.

Semi-steel is extensively used in internal-combustion engine parts, which have to withstand severe service and so must be strong and close-grained. Whereas grey cast iron has a transverse strength of 2,300 to 2,700 lbs., semi-steel often reaches 3,600 lbs. before breaking. Bars have been cast that did not break until a load of 4,000 lbs. was reached, though this is not to be expected in everyday practice.

In the earlier experiments steel scrap was added directly to the cupola, first in small amounts and gradually increasing to 40 per cent. The proportion has since been reduced until now 20 to 25 per cent. of steel scrap is considered good practice. The analysis of a mixture to produce a casting leaving a thickness of ¾ in., for example, should be: Silicon, 1.60 per cent.; manganese, 0.75 per cent.; phosphorus, 0.40 per cent.; and sulphur, about 0.09 per cent. To obtain this analysis in the casting, the charge should consist of 60 per cent. pig-iron, 20 per cent. steel scrap, and 20 per cent. cast scrap. The pig-iron should analyse as follows:—Silicon, 2.30 per cent.; manganese, 1.25 per cent.; phosphorus, about 0.40 per cent.; and sulphur, less than 0.05 per cent. If the manganese content of the pig-iron is too low, the deficiency may be made up by adding ferro-manganese to the cupola.

Semi-steel must be handled somewhat faster than grey iron. This fact must be considered when determining the size of gates and risers. When a riser is necessary, it should be about 50 per cent. larger than if for the same casting in grey iron. In allowing for shrinkage, ⅛ in. per ft. has been found to be satisfactory.

In the preparation of the mould, few deviations from ordinary practice are necessary. More new sand should be used in the facing, as much as one-half in some cases. In no case should the proportion of new sand be less than one-third. For castings weighing 500 to 2,000 lbs., a skin-dried mould is more satisfactory. The facing in this case should be made up of 20 parts sand and one part of pitch compound. For castings weighing more than one ton, a dry-sand facing liberally studded with nails is necessary. This facing is made by mixing one yard of heavy new sand, 12 cub. ft. of sharp sand, 140 lbs. of flour, and 2 qts. of molasses. All dried moulds should be given a coat of blackwash before being dried.

Pattern proportion is a very important detail in the manufacture of semi-steel castings. Before attempting to make a new casting, the drawings should be carefully examined in order to locate any heavy sections attached to light sections. If such are found, means must be found to feed these portions, or chills must be employed to make them solidify as rapidly as the remainder of the casting.

In making semi-steel castings, a sound, clean metal is the principal requirement. Some flux or scavenger is required in the ladle, the ones chiefly used being aluminium, ferro-titanium, or ferro-vanadium. Aluminium melts very rapidly and rises to the top, carrying with it most of the gases contained in the molten metal. The aluminium is rapidly oxidised and enters the slag in that form, leaving little or none of that metal in the casting. Ferro-titanium acts in much the same way as aluminium in that it removes gases. Its action is, however, more intense. One ounce of 15 per cent. ferro-titanium for each 100 lbs. of iron gives satisfactory results. Ferro-vanadium is used extensively in the manufacture of piston rings. Its principal value lies in the fact that it breaks up the large graphite flakes, thereby strengthening the casting. Iron treated with ferro-vanadium will withstand repeated shock better than an iron not so treated. Two ounces of 30 per cent. ferro-vanadium is enough to treat 100 lbs. of iron.

Discussion on Prof. Campion's Paper on "Modern Cupola Practice."*

Opening the discussion, the CHAIRMAN (Mr. T. Vickers) said that Prof. Campion was the only metallurgist in this country who had done extensive research work in connection with cupola practice, and it was for this reason that he (the speaker) had suggested that particular subject for consideration that evening.

MR. H. L. REASON endorsed the statement that the Professor had done some valuable work for the Institute in publishing the results of his researches, and said that in many ways he had furnished food for thought for the cupola makers. When one considers the antiquated cupolas that have been and are in use, one marvels at the wonderful results obtained, but there is no doubt that, with applied science, as explained by the Professor, the efficiency of the cupola can be considerably increased, but as it was generally agreed that blast pressure and air volume were points to be carefully watched, owing to the effect on the properties of the metal, he was surprised to note the Professor did not consider this aspect of cupola practice of fundamental importance, perhaps he would give his views on this point. As to the information and data given in the Paper, he was quite sure this would be used to good advantage by the members. He also paid tribute to the clear, concise way the Paper had been prepared, so that everyone could clearly understand all the various aspects considered.

Carbon and Oxygen Reactions.

MR. A. MARKS also considered that the information given would be of great value, and he fully agreed that Prof. Campion had probably done more work in regard to cupola practice than anyone else in the British Isles. He thought that constructional engineers should have their attention drawn to his suggestions, but these were also extremely useful to the practical foundry worker. The foundryman, he pointed out, was practically compelled to use cupolas of a certain size and construction because they represented the views of the various makers. He must confess that in his experience he had frequently been compelled to neglect what he might term efficiency of melting, and to consider only the metal turned out from the cupola, thereby setting aside many theoretical instructions regarding quantity, porosity of coke, etc. The coke burden they used was governed by the product. In addition there was the necessity to run on three or four different classes of iron, which compelled a variation in the amount of coke used. He would be interested to know what the Professor thought on the question of the taper in the shape of the cupola, and possibly he could tell them something as to whether the reaction between carbon and oxygen to carbon monoxide was not the principal source of melting heat, and that calculations as to fuel efficiency should be based upon this reaction rather than upon the reaction carbon plus oxygen to carbon dioxide. The carbon monoxide plus oxygen reaction probably occurred in the colder zones above the melting zone, and Prof. Campion's views would be of interest on this question, which was of vital importance in view of melting efficiency.

Shape of Cupolas.

MR. E. LONGDON asked what would be the effect upon the melting of an increased diameter in the cupola 15 or 16 ins. above the tuyeres. Perhaps the Professor would give them a little guidance as to the measurement of the coke bed, which was affected by the question as to what part of the cupola was the place of measurement, if one agreed that an increased diameter just above the tuyeres was desirable. Also what would be the effect of blowing in a jet of steam along with the air through a belt suitably protected against corrosion. While he had seen many mechanical chargers, none of them seemed to be without objections, and he thought the labour expended was about equal to that of hand charging.

MR. F. C. EDWARDS inquired whether experiments had been carried out as to the effects of oxygen; and also as to the time which ought to elapse between the charges where they were of a different character.

MR. T. HENRY TURNER agreed with the lecturer that the cupola was the oldest and crudest of furnaces, indeed, it had not been altered in principle, but only in the introduction of certain auxiliary plant. He suggested that they were apt to make a mistake in regarding the cupola from the point of view of its big brother the blast furnace, which was, of course, entirely wrong. Much that had been said about coke applied to blast furnaces, but not to cupolas, which were in this country comparatively small furnaces. One aimed at the production of the greatest quantity of molten pig-iron consistent with quality in a blast furnace, whereas in cupola practice one must aim for the *highest quality for a quite definite quantity* dependent upon the foundry requirements. No doubt what the lecturer had said about auxiliary plant was correct, but he thought that losses incurred through blast pipe friction, etc., were relatively negligible compared to the losses sustained through bad metal and useless destruction of moulds. If superheat was so important, how was it that some type of forehearth partial bessemerising and if necessary recarburisation was not practised? He emphasised the need of considering the cupola from the point of view of the casting rather than from the point of view of coke economy.

MR. W. ROXBURGH (B.T.H., Rugby) raised a point as to the iron mixture used where the melting was done with 1½ cwt. of coke to the ton.

THE CHAIRMAN remarked that a great deal of controversy had arisen over the question of tuyeres, and confident opinions had been expressed in favour of a small number of large tuyeres, while others, on the contrary, preferred a large number of small tuyeres. He would like to know whether the lecturer considered spiral tuyeres better than straight ones, and for what reasons. It was also important that the tuyere area should bear some ratio to the cupola area; some designers state that this is governed by the kind of metal to be melted. What would happen, therefore, in the event of miscellaneous mixtures being used? Another controversial point is if the air pressure is varied during a melt, has it any effect upon the melt?

THE AUTHOR'S REPLY.

PROFESSOR CAMPION, in reply to the discussion, said that certainly blast pressure by itself was of little value, and bore no relation to the quantity of air, neither was velocity or rate of entry of much significance, being only one factor in determining quantity of air entering and its distribution.

As regards the charging, he certainly did not mean to imply that all the coke should be on the sides and none in the centre; that certainly should not be, and he distinctly said the whole area must be covered.

As to founders being forced to take what the makers offered, as suggested by Mr. Marks, that was entirely the founders' own fault. If he wanted a certain design he should insist upon getting it; but, of course, the maker could not be held down to a guaranteed output or fuel consumption.

To work the cupola so as to give metal suitable for the job was correct, and, as he pointed out at the beginning of the Paper, it was not efficient working to melt metal that would not give the desired result in the castings. It was correct practice to vary the coke for different metals. Mr. Marks referred to metal that was perfect, but was not hot enough. He considered that metal too cold for the casting was far from perfect.

He preferred the straight lined cupola; it soon burned into its own shape. He did not believe in sloping the lining below the tuyeres; any splaying should be above the tuyere level, according to the rules he had given.

The question of equilibrium between CO_2 and CO and the zones of dissociation was rather too big a question to discuss in the time available, but perhaps he might have an opportunity to do so on another occasion.

He did not think that increased efficiency would result from blowing steam into the cupola; in fact, the reverse would be the case, as the action would be endothermic, and must be intermittent.

* See "F.T.J." page 455.

Mechanical chargers were an advantage with very large cupolas, but there was difficulty with distribution of the charges.

Pure oxygen blown instead of air would result in more active combustion and higher temperature, but it was hardly a practical proposition at present.

As regards separation of charges of different mixtures, he did not believe that was possible. If it was necessary to do so two extra charges of each mixture should be put in, the first and last of each lot tapped and put into castings of secondary importance. There is always some drip from the charge above. The mixture would thus be better separated. The reactions of the blast furnace were quite different from those of the cupola; the former were required mainly reducing, and the latter melting.

Metal could certainly be superheated by Bessemerising, but it would not then be cast iron, it would be steel.

The cupola he mentioned as melting with less than 1½ cwts. per ton was in regular work, and had a special type of internal belt.

Some doubt was thrown on the possibility of melting a ton of metal with 1½ cwts. of coke, but he had known that done on many occasions. It was being done in several light foundries. Where the products were heavier, as, for example, hot water pipes, they would put on 8 lbs. per cwt., which was a little below 1½ cwts. per ton. In rain-water gutters 9 lbs. per cwt. could easily be done. The metal used in that case was a mixture of 30 per cent. Scotch iron and 70 per cent. of Cleveland, but there was about 25 per cent. of scrap in the charge. As to the shape of the tuyere, he preferred it to be nearly square, 8 × 6 or 9 × 7; he did not believe in a continuous ring.

If the tuyere was too narrow it was liable to get filled up with slag. For a furnace over 4 ft. he preferred eight tuyeres, for a furnace 3 to 4 ft. diameter six tuyeres, and below 3 ft. diameter four tuyeres would be sufficient. If they were fitted with shutters it was possible to control the distribution of blast round the cupola. With regard to the means of producing blast, a fan was better for a small cupola, whereas for a big cupola he preferred the positive blower. After the first tapping of slag he would leave the hole to trickle all the time. One of the best preventives of sulphur was to secure a high melting temperature. The thing to be avoided was a low temperature. He believed there were great possibilities from the introduction of pre-heated blast, but all his information about the Schurmann cupola was second hand; he had never seen one at work.

Krupp's in Spain.—An agreement has been signed under which the mines and works of the Mieres Company (Asturias) are to be placed under the control of Messrs. Krupp, of Essen. The scheme involves the formation of a new company, with a share capital of 50,000,000 pes. (say £1,500,000), and an equal amount of debentures, apart from large sums deposited in various banks. Messrs. Krupp would not hold the majority of the shares, but would be charged with the technical control of the undertaking, for which purpose experts are to be brought from Essen. The Langreo Railway and some mines owned by this railway are excluded from the agreement. The Mieres concern supplies practically all the coal and patent fuel to the Northern, North-Eastern and other railway companies. The Mieres works were offered at a certain price to the Altos Hornos de Vizcaya, but the offer was declined when the German firm stepped in. The iron ore mines in Vizcaya are expecting important orders from the new company.

A Large Cast-iron Hydraulic Cylinder.

(FROM A CORRESPONDENT.)

The illustration below is reproduced from a photograph of a large one-piece cast-iron hydraulic cylinder, that has been supplied by Messrs. Glenfield & Kennedy, Limited, of Kilmarnock, for the London and North-Eastern Railway Co., and is a remarkable example of the art of the foundry.

This cylinder is 39 ft. 8 in. over-all in length without the sinking head, or 43 ft. 5 in. with the head added, and it weighs 4 tons 19 cwt., whilst including the head the total weight is 5 tons 12 cwt.

The internal diameter is 10¾ in., corresponding to 14⅞ in. externally, and it may be stated that the working pressure is 750 lbs. per sq. in., whilst it was tested to 2,500 lbs. per sq. in. in the makers' enormous testing machine.

A LARGE HYDRAULIC CYLINDER CASTING.

There are but few foundries which could tackle such a job, but of course Messrs. Glenfield & Kennedy's foundries are fitted with an extremely deep casting pit and special equipment to give homogeneous close-grained castings of unusual length, such as the present example. It may be mentioned incidentally, also that on being machined up the casting was found to be perfect in every respect.

Book Review.

Transport by Railway. By R. W. Pender, Barrister-at-Law. Published by F. Howard Doulton & Company, Limited, 15-17, Creechurch Lane, London, E.C.3. Price 1s.

This 20-page, paper-backed pamphlet covers ground which is of direct interest to the majority of our readers. It seems that the system of charges for railway transport is very much like Topsy—it was not born, it simply "growed up." Originally, they were borrowed from the earlier Canal Acts. In 1854, and again in 1873, efforts were made to simplify the conditions, especially in the matter of appeal against rates, the essential "reasonable" clause being inserted. In 1891 and 1892 Acts were passed which changed the rate from a ton-mile basis to a graduated system lessening the cost directly with the distance.

We believe that most of our readers would obtain a clearer perspective of the subject generally from a perusal of the book, which is an essential in any discussions as to change of rates at the tribunals which come into being from time to time.

CHRISTMAS & WALTERS, LIMITED, of Caxton House, Westminster, S.W., have received another large order for "Blawforms" for concrete shuttering from the Government of India, and again their conditions are such that they are shipping the material almost immediately after getting the order. "Blawforms" are now being used by all the large contractors in Great Britain, and economise well in labour and general costs over timber for all forms of concrete structures.

MELDRUMS, LIMITED, Engineering Works, Timperley, near Manchester, have lately taken orders for furnaces and stokers to 25 boilers of various types; 27 destructors from the small domestic type to burn 25 lbs. per hour up to the brick-built cell to burn over a ton of sawdust per hour; three sack disinfectors, and for chemical plant 50 units of steam jet apparatus, such as elevators, ejectors, silent boiling jets, compressors, pumps, etc., in "Meldrum" and other acid resisting metals.

XUM

Trade Talk.

VICKERS, LIMITED, Barrow-in-Furness, have received an important order for washing trommels for the Rand.

A LICENCE under the Non-Ferrous Metal Industry Act has been granted to Gain, Orr & Brett, Limited, 69-70, Mark Lane, London, E.C.3.

MR. C. E. DOUGLAS has removed from 34, Great James Street, Bedford Row, London, W.C.1, to 10, Gray's Inn Square, Holborn, W.C.1.

HENRY LEA & SON, consulting engineers, Birmingham, have removed to 151-153, Edmund Street, Birmingham. The company's Liverpool office has been closed.

BROWN, BOVERI & COMPANY, LIMITED, in order to avoid confusion with their Swiss house of the same name, have changed their name to the British Brown-Boveri, Limited.

THE WAGES regulated by the sliding scale under the Midland Iron and Steel Wages Board will remain unaltered from Monday, December 8, 1924, to Saturday, February 7, 1925.

WILLIAM THOMSON & COMPANY, of Leith, have given an order to Charles Connel & Company, Scotstoun, for a new Ben liner of 9,000 tons deadweight carrying capacity.

THE IMPORTS of foreign iron ore at the Senhouse Dock during November amounted to 7,140 tons, against 3,500 tons for October and 3,500 tons at the corresponding period of last year.

STEWARTS & LLOYDS, LIMITED, have secured a contract for the supply of 18 miles of steel piping of an average diameter of 36 in. The contract is for the Municipal Commissioners of Singapore.

FULLER'S UNITED ELECTRIC WORKS, LIMITED, of Chadwell Heath, Essex, have taken new premises in connection with their Bristol depôt at 22, Temple Street, where a full range of products will be stocked.

A LECTURE on "Steel and Light Alloys as Engineering Materials" has been delivered by Dr. Leslie Aitchison, Birmingham, at a meeting of the West of Scotland Iron and Steel Institute in the Royal Technical College, Glasgow. Professor Andrew presided.

MR. M. E. GALLON, past-president of the Newcastle and District Branch of the Institute of British Foundrymen, delivered an informal lecture on "Drawing and its Relation to the Foundry" at the November meeting of the members held at the Neville Hall, Newcastle.

ALFRED HERBERT, LIMITED, of Coventry, have for many years acted in conjunction with another company as joint selling agents for Norton grinding wheels in Great Britain and Ireland. Arrangements have now been made by which the company will in future act as sole selling agents for all Norton wheels in this territory. Stocks are carried at all the principal centres.

THE MAIN COMMITTEE of the British Engineering Standards Association have recently authorised the secretary, Mr. le Maistre, to accept the invitation of the German Standards Committee (the N.D.I.) to be present at their annual meeting on December 13. He is also going to Prague to give an address on "Industrial Standardisation" before the recently formed Czecho-Slovakian Standards Committee.

THE STRIKE at the Blackwall works of Baldwins, Limited, may have unexpected developments. Captain Dore has stated that the rates are so high in Poplar and the general state of labour is so bad that the management are seriously considering the permanent closing of the works and the transfer of the factory to a country site.

A NEW RADIAL DRILLING MACHINE has just been placed on the market by George Swift & Sons, Limited, of Halifax. The machine has eighteen spindle speeds through a nine-speed gearbox and single and double gear on the saddle, while the double gear is arranged between the drive and the reversing motion. It has an automatic trip motion fitted with an indexed dial and safety stop for preventing overtraverse of the spindle.

GEORGE GREEN & COMPANY, foundry engineers, etc., of Keighley, have just shipped a complete iron foundry melting equipment for the new works of the Portuguese State Railways, Lisbon. The plant consists of one of the firm's rapid "Economic" cupolas fitted with drop bottom and receiver, large self-contained charging platform with roof, direct-coupled motor fan for supplying the blast, 20-cwts. electric lift, sand and coal-dust mills, etc.

THE DATE for the next reunion of Old Ferrantians has now been fixed for Wednesday, December 17, at the Hotel Cecil, London. Dr. S. Z. de Ferranti will be the guest of the evening, and the chair will be taken by Mr. H. W. Kolle. It was originally announced that Mr. C. H. Wordingham would preside, but, owing to his illness, this will not be possible. The hon. secretary of the movement is Mr. W. E. Warrilow, 40 Mildred Avenue, Watford.

Contracts Open.

Bangkok, Siam, January 31.—Naval stores for the Siamese Ministry of Marine. The Department of Overseas Trade (Room 20), 35, Old Queen Street, London, S.W.1.

Belfast, December 15.—Supply and erection of specification "W31," steel framework for internal office building, for the Corporation. Mr. J. Wright, city electrical engineer and manager, East Bridge Street, Belfast. (Fee, £2 2s., returnable.)

Belfast, December 15.—3,000 galvanised steel bins for house refuse, for the Corporation. The City Surveyor, City Hall, Belfast. (Fee, £1 1s., returnable.)

Merthyr Tydfil, December 23.—5,000 tons of steel socket and spigot pipes of diameters ranging from 37 in. to 17 in., together with certain cast-iron pipes, valves and specials, all of British material and manufacture, for the Taf Fechan Water Supply Board. Sir Alex. Binnie, Son & Deacon, 30, Buckingham Gate, Westminster, S.W.1. (Fee, £5, returnable.)

London, E.1, December 31.—Cast-iron works, etc., for the Stepney Borough Council. The Borough Engineer and Surveyor, Municipal Offices. (Fee, £1.)

Tantah (Egypt), December 23.—The President of the Municipality of Tantah requires 17,500 linear metres of steel tubes and other materials for water pipe-lines. The Technical Bureau of the Municipality of Tantah.

Buenos Aires, May 27.—Cranes, etc., for the Argentine Department of Navigation and Ports. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. Ref. A.X.1496.

Cairo, January 13.—The General Manager, Egyptian State Railways, Telegraphs and Telephone, Cairo Station, requires five passenger engines. The Stores Department, Saptia (Cairo), or Gabbary (Alexandria), also the Inspecting Engineer's Office in London.

Manchester, December 23.—Supply and erection of the following, for the Electricity Committee, viz.:—Specification No. 83—three-phase 6,600-volt substation switchgear (various sub-stations); specification No. 84—steel flues for air heater (Stuart Street Station). Mr. S. L. Pearce, manager, Electricity Department, Town Hall, Manchester. (Fee, £2 2s. each specification, returnable.)

Montevideo, December 30.—Air compressors, for the State Electric Works, Montevideo. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. Ref. A.X.1502.

Sleights, Yorks., December 15.—Providing, carting and laying 1,760 lineal yards of 8-in. cast-iron water mains and valves, for the Whitby Waterworks Company. Mr. J. Taylor, secretary and manager, 55, Baxtergate, Whitby. (Fee, £2 2s., returnable.)

Company News.

Ajax Trucks, Limited.—Capital £3,000 in £1 shares. Directors: C. P. Rothwell-Jackson, 3, Dobson Road, Bolton; A. P. Hatton, 192, Toller Lane, Bradford; and C. C. Mossop.

Carmuirs Iron Company, Limited, Carmuirs Iron Works, Camelon, Falkirk.—Capital £25,000 in £1 shares. Directors: J. Wilkie, D. M. Wallace, G. C. Wilson and T. Morrison.

Hornsby & Goodwyn, Limited.—Capital £2,000 in £1 shares. General engineers, oxy-acetylene welders and cutters, etc. Secretary: W. R. Smith, Ruskin Chambers, Scale Lane, Hull.

James T. Donald & Company, Limited, 35, M'Alpine Street, Glasgow.—Capital £12,000 in 6,000 6 per cent. cumulative preference shares and 6,000 ordinary shares of £1 each. Iron and steel merchants.

Personal.

SIR JOHN WORMALD has resigned his seat on the board of Mather & Platt, Limited, and thus severed a connection with the firm that has lasted for 36 years.

MR. H. LAWSON, of Fairbairn Lawson Combe Barbour, Limited, and Mr. C. F. Ratcliffe, managing director of Brotherton & Company, Limited, have been added to the Commission of the Peace for the City of Leeds.

MR. M. M. GILLESPIE, of Gillespie & Beales, engineers, Amberley House, Norfolk Street, Strand, London, W.C., who has for many years represented Browett, Lindley & Company, Limited, Patricroft, Manchester, has been elected a director of the company.

Will.

COOK, J., for 64 years secretary of P. & W. Maclellan, Limited £13,256

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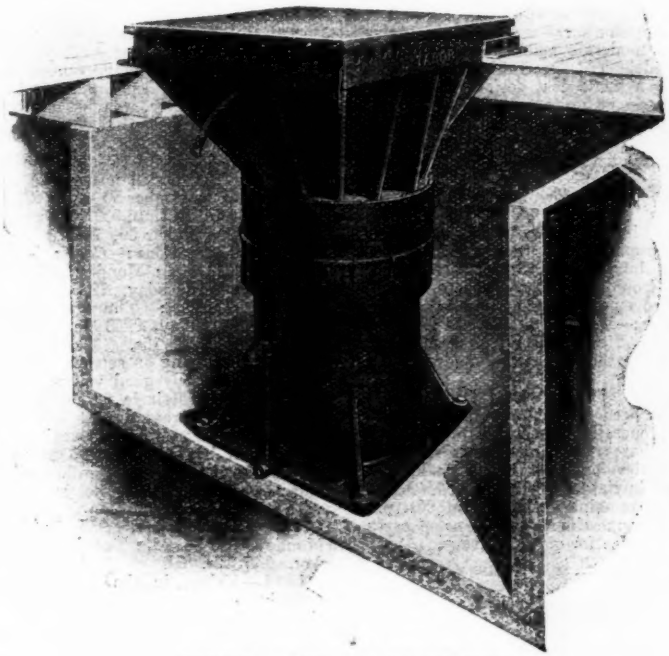

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Size	Size of Table	Load @ 80 lbs. air pressure	Size	Size of Table	Load @ 80 lbs. air pressure
6"	36" × 36"	1,000 lbs.	13"	42" × 60"	5,500 lbs.
8"	42" × 42"	2,000 lbs.	16"	48" × 72"	8,500 lbs.
10"	36" × 48"	3,300 lbs.	20"	60" × 72"	15,000 lbs.

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Conditions in the Teeside iron trade, as usually experienced at this period of the year, are quiet and uneventful, the majority of buyers having already closed their books until after the holidays, when the prevailing impression in market circles points to an active revival of business, both for home and export. At the moment, makers' stocks of foundry iron are very low, and it would probably be necessary to go from works to works on the river to pick up one good prompt cargo. Moreover, the export position is certainly more encouraging, notwithstanding last month's very poor shipments. Prices, on the whole, may be pronounced steady, and there would seem to be little ground for any anticipation of lower values. Makers continue to quote No. 3 G.M.B. at 82s., No. 1 87s., No. 4 foundry 81s., and No. 4 forge 80s. per ton.

Very little improvement can as yet be recorded in the hematite section, the general quotation for East Coast mixed numbers standing at 88s. 6d. per ton, though business has been done within the last week at prices both slightly over and slightly under this figure. On the North-West Coast business remains quiet, with Bessemer mixed numbers quoted at 99s. 6d. per ton delivered at Glasgow, 102s. 6d. per ton delivered at Sheffield, and 109s. per ton delivered at Birmingham. Low-phosphorus iron is in fair request only.

LANCASHIRE.—A gradual improvement is noted in the conditions governing the local markets for foundry pig, and at present a moderate amount of business is passing at 90s. 6d. delivered for Derbyshire No. 3 quality, and perhaps a trifle less for Northamptonshire. Makers appear to be quite satisfied with what has been done and with what is doing, and are not desirous of booking a large business for next year until it is known whether or not the furnace coke prices are going to be altered.

THE MIDLANDS.—Markets for pig-iron in this area are experiencing the inactivity customary at this season, most buyers having already covered their requirements for the present. It is improbable, therefore, that much big buying will take place before January unless the ironfounders' position opens up some immediate improvement. Ruling quotations for pig-iron are as follow:—Derbyshire No. 3 foundry, 82s. 6d.; forge, 77s.; Staffordshire No. 3 foundry, 87s. 6d.; forge, 80s.; Northants No. 3 foundry, 76s.; forge, 70s.

SCOTLAND.—Business in the local foundry iron market at present has been reduced to minimum proportions, consumers generally appearing to be fairly content with the purchases they have made recently, and inclined to wait developments before making a move in the way of buying further forward. The price of No. 3 foundry remains unchanged at 90s. per ton at the furnaces, but merchants are in some cases prepared to shade this price for quick delivery.

Scrap.

Reports from the various centres of the scrap metal trade, although indicating a slightly better outlook, are without material signs of general improvement, and business for the present is dull all round. In the Scotch market cast-iron borings still remain quiet around 42s. 6d. to 45s. There is no change in machinery cast-iron scrap at 90s., and second quality is at 5s. per ton less. This is for material suitable for foundries and in pieces not exceeding 1 cwt. Old cast-iron railway chairs are around 86s. to 88s., and for light cast-iron scrap 72s. 6d. to 75s., and, if mixed with firebars about 2s. 6d. per ton less. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—Movements in this section of the metal market have developed further strength in values of standard copper, closing quotations last week-end endorsing the firmness of the position. United States cables advise that the basic conditions of trade continue to show a gradual improvement. The temper of Wall Street is a good guide as to the general trend of opinion, and, as a rule, indications there precede by some weeks the movements in trade activity. In the case of copper, consumers recently were discouraged by the halting character of the market on both sides of the Atlantic, and by the signs of apparent nervousness in the attitude of producers. Current quotations:—*Cash*: Thursday, £63 15s.; Friday £63 17s. 6d.; Monday, £63 15s.; Tuesday, £63 16s. 3d.; Wednesday, £64 7s. 6d.

Three Months: Thursday, £64 17s. 6d.; Friday, £64 17s. 6d.; Monday, £64 15s.; Tuesday, £64 17s. 6d.; Wednesday, £65 7s. 6d.

Tin.—Stimulated evidently by the favourable nature of the statistical position, the market for standard tin has maintained a fairly steady tendency, though occasional fluctuations have resulted, due to the effects of speculative realisations. During the past week there was a renewal of American buying on a notable scale, which served to stimulate new speculative interest, and prices were lifted by several pounds. This improvement, however, was lost on a generally indifferent demand. Towards the close of the week a further advance was marked.

Ricard & Freiwald estimate the total visible supply of tin (stocks and landing and afloat, Europe and America) at November 30 at 19,627 tons, against 18,121 at October 31 last, 16,909 at November 30, 1923, and 22,346 at November 30, 1922.

Current quotations:—*Cash*: Thursday, £259 10s.; Friday, £258 10s.; Monday, £255 12s. 6d.; Tuesday, £256 10s.; Wednesday, £256 10s.

Three Months: Thursday, £262 10s.; Friday, £261 10s.; Monday, £258 15s.; Tuesday, £259 12s. 6d.; Wednesday, £259 15s.

Spelter.—Buying on consumers' account of this metal continues in fairly good volume, and active conditions prevail. The intrinsic value of spelter based on the considerably increased cost of production compared with pre-war conditions is variously placed at £32 to £33 a ton, but smelters are now more strongly situated, and the market is influenced by the fact that European production is not sufficiently large to cope with current consumption. Current quotations:—*Ordinary*: Thursday, £35 2s. 6d.; Friday, £35; Monday, £35 3s. 9d.; Tuesday, £35 11s. 3d.; Wednesday, £35 12s. 6d.

Lead.—Values in the market for soft foreign pig have been subject to some irregular fluctuations, but the position is very well held, and there is no doubt that manipulation in this particular commodity is becoming a fine art. It would be interesting to know exactly what users think of the present position. Their only remedy is to look after supplies for themselves and to band themselves into a buyers' defence association. Current quotations:—*Soft foreign (prompt)*: Thursday, £39 15s.; Friday, £39 10s.; Monday, £39 10s.; Tuesday, £40; Wednesday, £40 2s. 6d.

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